JUL 25 1921

Engineering News-Record

Devoted to Civil Engineering and Contracting. McGraw-Hill Company, Inc.

July 21, 1921

Susitna Bridge, Alaska Government Railway

Three Concrete Road Construction Methods Compared

Fire Resistance of Building Columns as Shown by Furnace Tests

By R. E. Wilson

New Philadelphia Asphalt Plant Has 4000 Square Yard Daily Capacity

By H. T. MacFarland

504-Foot Steel Channel Span of Susitna River Bridge Avoids Risk of Destruction in Ice Jams

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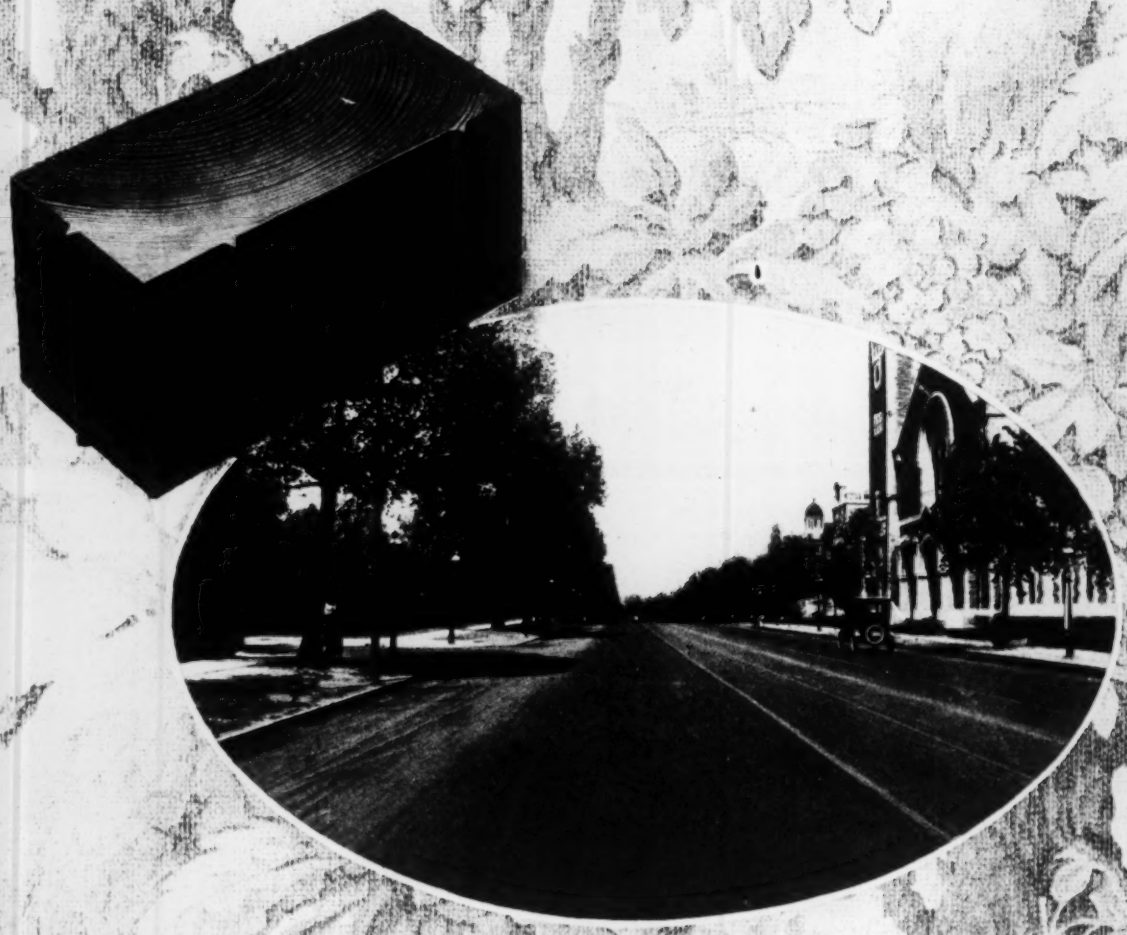

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 87 — NEW YORK, JULY 21, 1921 — Number 3

A Fact for Port Boomers

FIGURES just given out show that the three leading grain export cities in the United States for the United States for the fiscal year just ended were Galveston, with 86 million bushels, New York with 51 million and Baltimore with 32 million. A stranger to this country might assume from this that Galveston is a large and prosperous city. The fact is that it is still under 50,000 in population and is increasing more slowly than the average industrial city of the same size. There is a lesson here for those local enthusiasts who see ruin or prosperity, as the case may be, in the degree of bulk transshipment business at any port.

Truck Mortality in Road Construction

INFORMATION of unusual interest, because verified data are exceedingly rare, is given in the article in this issue on the life of light trucks hauling dry batches for concrete road construction. After the first few days, only 80 per cent of the trucks were in condition for service and at the end of the season 80 per cent of all had so deteriorated that they were practically useless for further hard service. On its face, this record seems to condemn the one-ton truck as an economic method of hauling concrete materials over ordinarily bad country roads. This conclusion is not true. The trucks broke down because they were carelessly driven and inadequately maintained. No machine will give constant service nor will it endure, under such conditions. Throughout the work described the trucks were abused in operation by careless boy drivers employed because they would work for wages which experienced drivers would not accept. Under the conditions of labor shortage which existed, perhaps the contractors cannot be severely criticized for employing the help he could obtain most easily at the lowest wages, but the lesson is nevertheless very plain. Truck service and endurance depend directly upon maintenance and maintenance upon skilled drivers.

Road Bill Prospects

THIS week's news from Washington offers little cause for enthusiasm among the supporters of amendments to the present federal highway law and an appropriation of funds for federal aid at the rate of $100,000,000 yearly. It is possible that the proposed highway legislation embodied in the Townsend and the Phipps-Dowell bills may go the way of the soldiers' bonus bill in the general campaign for economy which is being carried on at the national capital. Irrespective of worthiness of the cause, increased appropriations are not meeting with much favor now on the part of Congress. It is true that there still remains a sizable slice of federal funds available for use in state highway construction, but this sum, substantial as it may appear, represents an amount which is awaiting use by those states which have been slowest in carrying out their construction programs. The progressive states, on the other hand, have, as a general rule, absorbed all of their federal allotments, so that failure by the present Congress to make available additional federal money for road work will disrupt the road-building program and the engineering organizations in those states which have been most active in road building. It is misleading, therefore, to cite as an argument against further appropriations the fact that all of the money previously made available has not been used. If further federal-aid appropriations are withheld by Congress, such action will be justified only by the need for the most drastic economy in the conduct of the Government's business and not because, apparently, a certain amount of federal money for road construction still remains to be absorbed.

Engineers in South Africa

IT IS interesting to learn from the presidential address of R. W. Newman, before the South African Society of Civil Engineers, that the profession there is giving thought to the same questions which are occupying the minds of American engineers. There is complaint that the engineer has received tardy recognition in that country, and there is coupled with it a demand that the views of civil engineers be given consideration when public matters of an engineering character are at issue. It is also of interest to note the emphasis which Mr. Newman places, particularly in addressing the younger members of the society, upon the need for close study, by the engineer, of the financial features of the projects on which he is engaged as of the engineering. "The civil engineer," he says, "must create more production by keeping the cost of his designs and his construction within the limits of a dividend earning line," and he applies the rule not merely to private enterprises but to public works as well, the dividends on the latter being, obviously, in terms of service to the community. The reading of the address cannot but help strike a responsive chord in the hearts of American engineers.

Road Roller Charges Cut

HIGHWAY engineers and contractors are informed in this week's news section of a reduction in rental charges for the patented light roller which has found such an extended use in the finishing of concrete roads. A considerable amount of dissatisfaction had been expressed of late at what were regarded as excessive charges for the use of the method and the device and at least one state highway department had about reached the point of altering its specifications so as to substitute some other form of surface finishing than the one involving the concrete roller. The Macon company has acted wisely in presenting its schedule of lowered charges. The light roller is a convenient and effective tool in the production of good pavements and it would have been short-sighted to provoke a boycott.

Should Consulting Engineers Be "Fired"?

AMONG engineers of New York's metropolitan district the case of the "dismissal" of the board of consulting engineers for the Hudson River vehicle tunnel has occasioned widespread comment. Eliminating the various local aspects of the controversy, two broad general issues seem to be involved: First, the justification for discharging a group of distinguished professional advisers without substantial reasons therefor and without the opportunity of a hearing—as an office boy might be "fired"—and, second, the propriety of acceptance by other engineers of appointments to positions made vacant under such circumstances. It is these issues which form the subject of an opinion by a committee of the New York Chapter of the American Association of Engineers, which has just concluded an investigation and report on the vehicle tunnel controversy, as set forth in the news section of this week's issue. Approved by the association's board of directors, the findings of Messrs. Lavis, Sanborn, and Hogan are to the effect that the New Jersey tunnel commission has acted in a manner prejudicial to the tunnel enterprise and to the public welfare, and that the two engineers who accepted positions as technical advisers to the Jersey body, after the members of the consulting board had been hastily ousted, displayed poor taste and a lack of a fine appreciation of professional courtesy and ethics.

It would be ridiculous, of course, to contend that an individual or a public body should not be able to dismiss its technical consultants if the latter prove incompetent or undesirable for other good and sufficient reasons. In the present case, however, the Jersey commission has not come out into the open with any specific charges, but attempts to justify its action by a veiled accusation of failure on the part of the consulting board to give the tunnel project "full and proper consideration." It should be emphasized, also, that the New York commission, which is vested with authority equal to that of the New Jersey body in the administration of the tunnel project, has vigorously opposed the Jersey commission's action, and that the chairman of the Jersey commission, on every occasion when a call for legal opinion on the case was made at its meetings, studiously prevented such opinion being given, although the commission's counsel sat at his elbow. During the investigations of the A. A. E. committee the Jersey commission refused to give any information, and throughout the controversy its tactics have not been such as to inspire confidence in its motives. The fact that no vouchers for the payment of Jersey's two new technical advisers have been approved is a further indication of the doubt surrounding the legality of its dismissal action.

In view of these conditions the two new technical advisers used poor judgment in accepting the New Jersey appointments. Unquestionably they acted within their legal rights but it would have been far more gracious on their part to have withheld acceptance until the legality of the dismissal of their predecessors had been definitely established. The question of the professional ethics in the case is a nice one. The A. A. E. committee has answered it in a reasonable, fair-minded and discriminating manner. If its report will serve to speed up action in deciding the status of the consultants, it will have done valuable service.

Exceptional Conditions

FOR fullest instructional value the record of the Susitna bridge on another page of this issue would be more complete did it contain a specific analysis of the difficulties to be overcome and the alternative possibilities as to solution. Not a few structural engineers have been inclined to a feeling of wonder or even question why so large a span was necessary for crossing a stream of moderate size, merely in order to avoid ice danger to intermediate piers. The statement made, that the longer span was cheaper than two shorter spans with a channel pier, is direct and unqualified yet in view of the various possibilities of arrangement of the crossing even this point would have been covered in a more informing way by a frank discussion of the possibilities and their comparative merits.

While one may feel somewhat regretful over the lack of fuller explanation, it is necessary to bear in mind that data for estimating the destructive power of ice shove in definite figures are scanty and that their applicability to the Susitna crossing is questionable. Where ice-thrust danger is combined with the chance of active scour, the prudent engineer may well conclude that even at large extra cost it is wisest to avoid the risk. The frequency of bridge foundation failures argues effectively against taking unnecessary risks with foundations exposed to severe attack.

It is to be presumed in the absence of a discussion of this point, that the site is such as to remove the piers of the large span from all major exposure to ice and scour, and at the same time that nothing short of a 504-ft. span would have given comparable security. Otherwise a comparison of the relative safety of alternative layouts would be bound to take into account the risk of destruction of the main span piers, not merely the risk to which a channel pier would be exposed. In ordinary streams, where scour in its erratic occurrence may attack a pier near the bank almost as readily as a mid-channel pier, and where ice pressure is by no means restricted to the center of the stream, a layout like that of the Susitna bridge would not often prove desirable. The conditions, if fully stated, might well prove to be so exceptional as to be entirely individual to the one stream and crossing involved.

A Fundamental Research

PIONEER data are made available to the structural engineer in this issue through R. E. Wilson's analysis of test data on the fire resistance of bare and protected columns. In compact, digestible form are set forth the principal results of an investigation that stands quite without precedent.

Fire conditions control the design of buildings, yet in most of its details this control has hitherto been of rather impressionistic kind; engineer and architect *believed* that a particular amount and kind of fireproofing was adequate, without tangible reason for holding this belief. Now, for the first time, specific data on the value of column fireproofing are to hand. They affect very large expenditures of money—a considerable fraction of the whole cost of industrial and city building construction. Safety as well as economy is served.

In studying these tests, the engineer will not fail to observe that the results are qualitative, rather than quantitative. This represents a limitation upon their

applicability. They establish the relative rank of two forms of fireproofing, but do not directly enable the engineer to proportion his construction to the intended service of a particular building. They tell him that a given form of column protection will resist the standard test-fire for, say, three hours, but they do not tell whether that form of column protection is suitable for use in a paper warehouse or a department store in the heart of a city. Ultimately the fire protection specialists should give him this specific information.

The major value of the present tests lies in the fact that they establish an efficiency grading of different methods and types of fireproofing. A glance at the diagrammed results shows that there are wide differences of value between forms of fireproofing that have heretofore been considered of substantially equal efficiency. The tests thus make it possible to avoid waste of money on inefficient constructions. In addition they point the way to improvement of all types of fireproofing to full efficiency, since they reveal the causes of premature failure.

Some quantitative use of the present test results may be found possible in addition to their use for comparisons. Correlating the behavior of fireproofing in the tests with observations on actual buildings in severe fires may enable the engineer to arrive at some estimate of the amount of fire protection that should be provided in a particular type of building. Such individual estimates will be of value, so far as they go. The ultimate objective, however, is a complete co-ordination of building service and fire protection to the end that the designer may be enabled to provide full protection at minimum expense.

Specifying Concrete Quality

FIVE years ago when the final report of the Joint Committee on Concrete and Reinforced Concrete was presented the criticism was made that it overemphasized design. That document was colorless in so far as the manufacture of concrete was concerned; it contained merely a platitudinous digest of the common knowledge of concrete the material, a digest which itself might have been abstracted in some such words as "use good materials and mix and place them in workmanlike manner." Design, on the other hand, was most elaborately detailed, though, except for the section on flat-slabs, it was merely a repetition of long established practice set forth in the text books. In the main that report reflected current ideas. In spite of the fact that few concrete failures could be attributed to deficiencies in design and that the manufacture of the concrete itself was notoriously variable and its strength and wear uncertain, most engineers were satisfied with vague generalities regarding the material itself and were prepared to accept specific and limited stipulation regarding design. In effect, they were content to let a foreman control the future of a structure in which they figured the coefficients of design to the last hundredth. Today their attitude is very different, and the tentative draft of the new report gives expression to this changed view.

Since the earlier final report was issued there has been great activity in the study of concrete, the material. It has been recognized that variations in proportioning, mixing and placing may vitiate all of the refinements of design and that these variations involve elements beyond mere rule-of-thumb methods or so-called practical knowledge. In proportioning alone, in the establishment of the proper grading and amount of the aggregate and the amount of the water, we are in the beginnings of a new art, with several schools of investigators feeling their way along different roads to what is probably the same goal of determinate proportioning. Control of the concrete is on the way to becoming as precise as its design has long been.

Recognition of this development in concrete is the outstanding feature of the tentative specification of the new Joint Committee which has just been submitted for discussion, and which was digested on p. 68 of our last issue. To be sure, design still forms the major part of the specification, and refinements in stress analysis, based on elaborate studies of the rapidly multiplying number of tests, are greater than ever, but at the very beginning of the specification the strength capacity of any given concrete is based on the behavior of that particular concrete and not on some average value that a group of approximately similar concretes reached.

The novelty of this method of approach is reflected in the specification, for while the design provisions, even those which are new, are single and definite, the quality provisions are alternative, in the effort to meet the various schemes put forward. The committee quite rightly is not prepared to accept any one scheme for predetermining strength, and so with one exception falls back on the actual test of the concrete to be used, and even goes so far as to offer an alternative clause whereby the engineer will merely require the contractor to produce concrete of the required short-time test-specimen strength, regardless of proportions, though presumably the general specifications as to quality and composition of the aggregate and of the cement must be observed. The one exception noted is the presentation of a tabular list of strengths for various mixes, which gives undue emphasis to the results obtained in one laboratory. The criticism may also be made that consistency, a now recognized element in strength, is specified by the not too well authenticated slump test, although this is probably offered for lack of a better measure.

It is evident that while these quality provisions of the specification form a great and radical step forward from the old report, they are still of the most tentative nature and subject to many revisions in the next few years. The design clauses, from their very nature, are more precise, and while they may be subject to discussion, they are based on mathematical truths in the interpretation of which there is opportunity only for slight difference of opinion. The recognition of column bending and of continuous deformation of reinforcement under load is new and will provoke discussion; the distribution of moments in the flat-slab within limits must remain arbitrary and the committee had to settle on some values though they may not be universally acceptable. Shear is still a debatable subject. After all, within the year allowed for discussion the provisions of design may approach unanimous acceptance.

The study of quality, on the other hand, and the fine points of mixing and placing are still in a state of flux and the specifications in the treatment of these subjects can hardly hope to be final even a year from now. But the joint and expert recognition of the peculiarities of the material concrete is a milepost in the art of construction.

The Susitna River Bridge: Alaska Government Railway

Steel Channel Span 504 Ft. Avoids Ice Jams—Timber Flanking Spans—Concreting Done at 12 Degrees and Riveting at 42 Degrees Below Zero

THE longest bridge span on the United States Government Railway in Alaska is the new steel 504-ft. through-truss channel span of the Susitna River bridge, which was completed in February, 1921. The crossing of the Susitna includes two 121-ft. combination Howe-truss flanking spans and two 70-ft. combination pony Howe-truss end spans, with 392 ft. of trestle at the southern approach and 28 ft. at the northern approach, making a total length of 1,322 ft. It is located 150 miles north of Anchorage, the ocean port of the line, and 264 miles north of the terminus at Seward.

In a study of the river under summer and winter

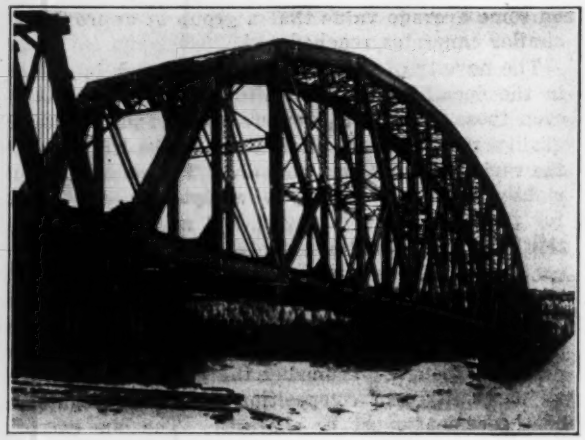


FIG. 1. SUSITNA RIVER BRIDGE IN ALASKA; U. S. GOVERNMENT RAILWAY

conditions as a preliminary to the design of the bridge, high-water marks and ice scars on trees indicated the elevation reached by the ice while in motion. The spring break-up occurs usually before the ice has become soft, and in passing downstream massive pieces jam against the islands and bars and against the shore at points where the river takes a sharp turn, the water then rising until its pressure breaks the dams. It appeared evident that such rushes of accumulated water and ice would carry out any timber pier and that a concrete pier would be exposed not only to the tremendous pressure of the ice jam but also to undermining by the scour that would result from the creation of an ice dam against the pier. A comparative estimate for the structure over the main channel to consist of two 250-ft. steel spans on three concrete piers (with one pier near the center of the channel) or a single 504-ft. steel span on two concrete shore piers, slightly favored the long span, which therefore was adopted.

The combination of steel trusses and timber trusses in the same bridge is considered to be justified by the high price of bridge steel and concrete work at the time of construction, it being cheaper to build all approach spans of timber and to make provision for possible renewal with steel and concrete when the life of the timber has reached its limit. For this reason the main piers were designed to support 200-ft. steel flanking spans at some future time, each to replace the present 121-ft. and 70-ft. spans.

The Cooper E60 loading was adopted for the 504-ft. span, E50 for the timber and E44 for the trestling, which has 14-ft. spans. In the design of the steel span the 1910 specifications of the American Railway Engineering Association were followed mainly. Wind loading was an exception to this; the bottom lateral system was designed for 40 lb. per sq.ft. on the area of train and floor in elevation, and on 1½ times the area of truss members of one truss not covered by train and floor, while the top laterals were designed for 500 lb. per lin.ft. of span.

Pier Foundations and Construction

Test holes 60 to 75 ft. deep to determine the character of foundation for the concrete piers disclosed compact sand, gravel and large boulders in layers of varying thicknesses, suitable for carrying pier loading without foundation piles.

Pier construction started in May, 1920, when the head of track was 22 miles south of the bridge site. Supplies were freighted by sleds on the ice until the river broke and then by boats and wagons. Transportation difficul-

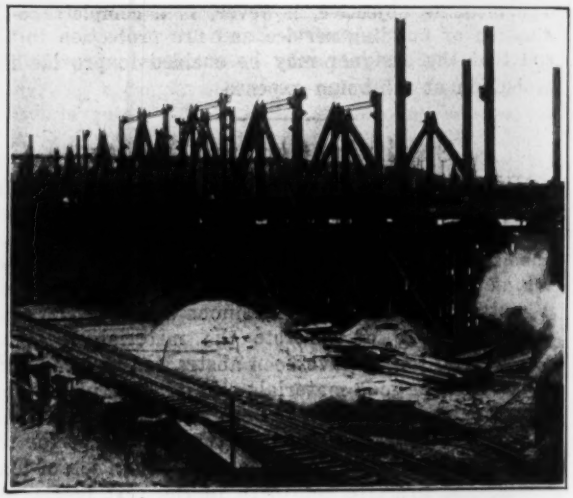


FIG. 2. ERECTION OF 504-FT. SPAN (NOV. 29, 1920)

ties were practically overcome when the track reached the river in September, 1920. At that time excavation for the south pier was complete and that for the north pier had been begun. A temporary trestle 100 ft. downstream from the bridge site permitted tracklaying to proceed and facilitated erection of the bridge without interference to traffic and to other construction work north of the river. Piles for the trestle bents, piers and abutments had been driven and the falsework for the steel span had been started from the north end before the track reached the site.

An open caisson was used for the north pier excavation, and a cofferdam of Wakefield triple-lap sheet piling for the south pier. Excavation was started in the wet with orangepeel buckets operated by two stiff-leg derricks until hard material was struck; then the holes were pumped out and work was continued by laborers

with pick and shovel filling dump boxes operated by the derricks. For both foundations, excavation was carried to an average depth of 25 ft. below the ground. Drain ditches about 12 in. deep were maintained around the edges, being sloped to carry seepage water to a sump at the downstream end of the pit where one 5-in. and two

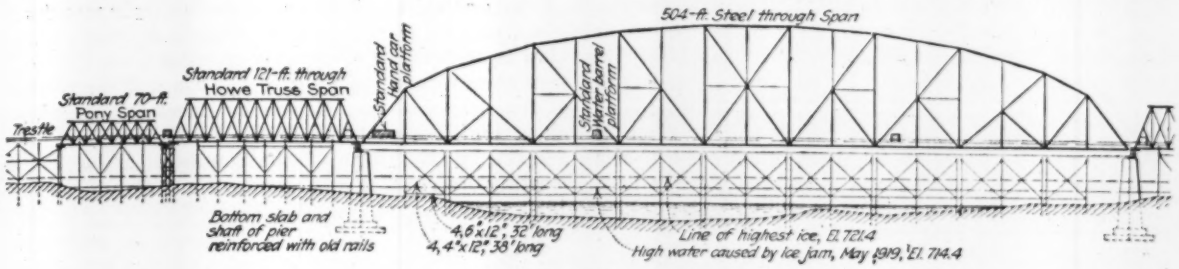

504-ft. Steel through Span
Standard hand car platform
Standard 121-ft. through Howe Truss Span
Standard 70-ft. Pony Span
Standard water barrel platform
Trestle
Bottom slab and shaft of pier reinforced with old rails
4,6"x12", 32' long
4,4"x12", 38' long
Line of highest ice, El. 721.4
High water caused by ice jam, May 1919, El. 714.4

FIG. 3. CHANNEL SPAN AND FALSEWORK

8-in. pulsometer pumps operated continuously in the lower levels of the work.

Concrete Work.—Considerable difficulty was encountered in finding sand and gravel suitable for the concrete piers. Aggregate taken from pits in the vicinity of the bridge was not satisfactory, as samples showed humus. Several deposits along the railway line all showed the presence of this constituent in various amounts, except samples from a pit in a glacial moraine in front of Spencer Glacier, 56 miles north of Seward. This deposit tested clear and was used; 7 per cent of sand was added to the bank aggregate, which was deficient in this respect.

After a partial failure in one of the piers during September, 1920, caused by poor cement, the presence of humus in the aggregate and the low temperature of the air and water, special measures were resorted to in placing concrete in main piers.

When the cofferdam was unwatered, the bottom of the enclosure was under a 22-ft. head of water from the river, and owing to the porous nature of the boulder and gravel formation considerable water was forced through the floor of the pit. The enclosure was 33 x 69 ft. and it was found impracticable to partition it off and place and hold concrete in the dry against the flow of water. As the low temperature of the water (35 deg. F. in November) and the large area (2,277 sq.ft.) made it impracticable to place concrete under water by bucket or pipe methods, the following plan was devised to meet the conditions of cold running water and low air temperature. A large sheet of canvas was prepared in one piece, sufficient to entirely cover the bottom area and extend about 6 ft. up the sides of the enclosure. This canvas was "formed-in" by wooden forms along the sides and ends, to provide a runway for water around the edges. Steam coils were placed around the sides of the pit

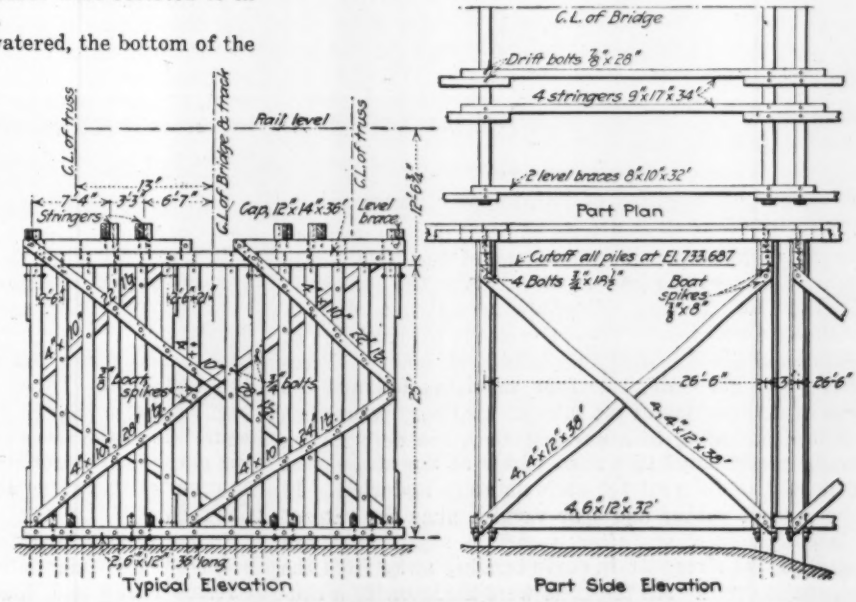


FIG. 4. FALSEWORK FOR 504-FT. SPAN

inclosure and the entire space was housed in and made warm. Sand and gravel delivered on cars were heated by being dumped on a platform holding perforated steam pipe coils, and hot water was used in mixing.

Concrete was poured at the south pier, containing 1,456 cu.yd., from Oct. 24 to Nov. 11, 1920, during which time temperature readings ranged from —2 deg. to +48 deg. F. At the north pier, containing 1,520 cu.yd., the pouring was from Dec. 1 to Dec. 18, 1920, when temperatures ranged from —12 deg. to +34 deg. F. The pit was kept unwatered, and the concrete was placed from chutes and pipes leading from mixer to pier. All concrete was given sufficient time to set before allowing cold water to come in contact with it.

Erection of Steel Channel Span

To hasten erection of the 504-ft. span, it was necessary to proceed without waiting for completion of the piers. Falsework for this span, as mentioned, had been driven from the north end. The north approach trestle, piers and falsework for timber spans were driven and a temporary deck laid. One of the 70-ft. pony spans was used temporarily to span the excavation for the north pier, thus permitting the construction of this foundation.

Erection of steel started Nov. 8, 1920, from the north end at panel point No. 2, a yard having been constructed on the north side of the river which was reached by

means of the temporary trestle. Erection was continued to the south end and all steel except for the two north panels was assembled by Dec. 15, 1920. Steel in these two panels which did not interfere with the 70-ft. pony span was placed after Dec. 25. As soon as this temporary span was removed, the rest of the steel was placed, completing the erection on Jan. 8, 1921.

A 100-ton locomotive crane with a boom having extensions to make a total length of 85 ft. was used for the erection, being supplemented in the yard by a 35-ton locomotive crane with 50-ft. boom. The total weight of steel in the span is 1,803 tons. Only a little riveting was done until after Dec. 20, 1920, when over 90 per cent of the span was in place, but the work was then pushed until completion on Feb. 9, 1921, during which time temperatures ranged from —42 to +34 deg. F. On some cold and windy days the riveters did not work; but on one occasion rivets were driven when it was —42 deg. in the morning and —12 deg. at quitting time. Rivets driven during very low temperatures were retested several times later in warmer weather and showed firstclass work. The total number of field rivets was about 42,200.

The span was swung Feb. 2, 1921, and the first train passed over on Feb. 6. The work of erecting the timber spans and finishing the trestle progressed simultaneously with the steel erection, so that the bridge was entirely completed and ready for service on Feb. 16.

General supervision of the work was under Col. F. Mears, chairman and chief engineer of the Alaskan Engineering Commission. The preliminary design of the 504-ft. steel span and the design and details of the timber spans and foundation work were made by W. J. H. Fogelstrom, former bridge engineer for the Commission, assisted by F. H. Chapin, assistant bridge engineer. Final design and details of the 504-ft. steel span were made by the American Bridge Co., which also fabricated and erected the steel. All designs and detail plans of steel work were checked and approved by Modjeski & Angier, consulting engineers, Chicago; Hildreth & Co., Chicago, performed the inspection of steel at mill and shop.

Tensile Properties of Paint Films Measured

In a series of tension tests of paint films carried out by H. A. Nelson in the laboratory of the New Jersey Zinc Co., as reported by him before the American Society for Testing Materials recently, a distinct difference was found between normally oxidized film of paint and varnish, and thin sheets of rubber. Peculiarly enough, high-grade spar varnishes followed the law of deformation of the rubber. Ordinary paint films deform according to a parabolic law, the deformation being proportional to a fixed power of the stress (the exponent is different for each different material). In the case of rubber and spar varnish films the rate of elongation decreases after a certain stress has been reached, the stress-strain curve bending away from the elongation axis. All the tests were made under a constant rate of application of load per unit cross-section of paint film per minute, as it was found that speed of loading had a profound influence on the results. The exponent of the stress ranged, for the different materials tested, from 1.0 to 2.2, being lowest for kettle bodied oil and highest for enamel, highly oxidized paint and varnish. However, the coefficient of the exponential term is by far the lowest for these latter materials.

State Treaty Settlement of Interstate Water Controversies

By A. Lincoln Fellows
Denver, Colo.

THE legislatures of the states including the Colorado River Drainage Basin have, during their recent sessions, enacted certain laws of unusual interest, with a view to settling, or attempting to settle present and future controversies relating to the use and distribution of the waters of that stream by interstate agreement, along the lines proposed in the resolutions that were adopted by the League of the Southwest at its Denver meeting described in *Engineering News-Record*, Sept. 2, 1920, p. 477.

In particular, the State of Colorado, in making its so-called Water Defense Appropriation, has extended the provisions of the Act to as to include all necessary expense incident to interstate adjustment respecting any of the five streams concerning which treaty measures have been passed, viz., the Colorado, La Plata, Arkansas, South Platte and Laramie Rivers. Delph E. Carpenter, an attorney specializing in irrigation law, who has for a number of years been engaged by the state as counsel in interstate water litigation, and who is thoroughly conversant with both the legal and the engineering problems involved, has been appointed commissioner to represent the state on all of these streams.

This procedure is also along the lines suggested in the article by R. I. Meeker, on "Interstate Water Conflicts and Possible Solution," in *Engineering News-Record*, Jan. 27, p. 157. The plan is based upon the theory that the states involved should endeavor to settle their differences amicably before taking them to the Supreme Court of the United States, just as nations ought to arbitrate before declaring war. It is claimed that this course is possible for the reason that while, by the constitution of the United States, the states surrendered certain of their powers to the central government, they still retained the power of entering into treaties among themselves with the consent of Congress. For example, the treaty powers of the states have frequently and successfully been invoked in the settlement of disputed boundaries through interstate compacts, ratified and approved by Congress.

In line with these views and at the request of Governor Campbell of Arizona, president of the League of the Southwest, bills were drawn for submission to the legislatures of the seven states represented in the League and forwarded to the state representatives in January, 1921. These measures provide for the appointment of a joint high commission made up of representatives of the seven states and the United States for the purpose of negotiating and entering into a treaty or compact respecting the future use of the waters of Colorado.

In harmony with this action, special bills were also prepared for interstate commissions on four other streams rising and flowing for long distances within the State of Colorado, the Arkansas, South Platte, La Plata and Laramie, involving Colorado and the states of Kansas, Nebraska, New Mexico and Wyoming, respectively. The commissioner for Colorado on the Colorado River Commission is to serve as commissioner regarding the other rivers also.

The series of treaty bills introduced before the Colorado Legislature passed without a dissenting vote. It

is understood that New Mexico has agreed to join Colorado in submitting questions relating to La Plata River to the consideration of an interstate commission and that Kansas and Nebraska have signified their willingness to consider similarly problems respecting the Arkansas and South Platte Rivers. Also that Wyoming and the rest of the Colorado River states have enacted similar legislation and commissioners have been appointed in most of these states. The outcome of these negotiations will be awaited with interest.

Valve Closing Trucks Employed by Detroit Water-Works

MOTOR trucks with a valve closing mechanism give excellent service in Detroit, Mich., when broken mains or other emergencies require large gate valves to be quickly closed. A small Buick truck equipped with a makesift mechanism in 1913 had given good service. Therefore, in 1918, a definite study was undertaken with the engineers of the Packard Motor Car Co., to plan a truck for closing valves. Two were built and are now in service, in conjunction with a repair truck hauling a tool-box trailer, making emergency repairs.

Packard trucks have a power take-off shaft from the transmission case for operating mechanical devices on the truck. The device for valve closing, as is indicated by Fig. 1, is located at the left of the driver's seat, and consists of a vertical shaft actuated by the power take-off shaft through a succession of gears and chain drives. The vertical shaft may be raised and lowered by a hand wheel. It can be operated in reverse to open valves and there is a counter which registers the number of turns in either direction and has a set back to zero. There is a spot light on the dash to illuminate the ground and valve box for night work and a siren and bell to warn traffic when an emergency run is being made.

As indicated by Fig. 2 the lower end of the shaft has a square key-head, and all valves have an extension stem with a square key-head. With an assortment of double-end socket-wrenches the operating shaft on the truck is keyed to the valve stem. In operation the truck is spotted over the street box by means of the pointer shown by Fig. 2, the operating shaft is lowered, the proper wrench is inserted and the power is thrown on. A table attached to the front end of the truck body, back of the operating shaft, indicates the number of turns required to close the valve. About 220 turns are required to close a 48-in. valve and the shaft makes about 25 turns a minute. Formerly by hand it required 25 minutes for four men to close a 48-in. valve. In machine closing, the only precaution necessary is to slow down the speed as the valve is nearly closed. Two men operate the truck, but in emergency, and in a little more time, one man can perform the task. Wrenches, lanterns, rubber boots, valve location books and other paraphernalia required

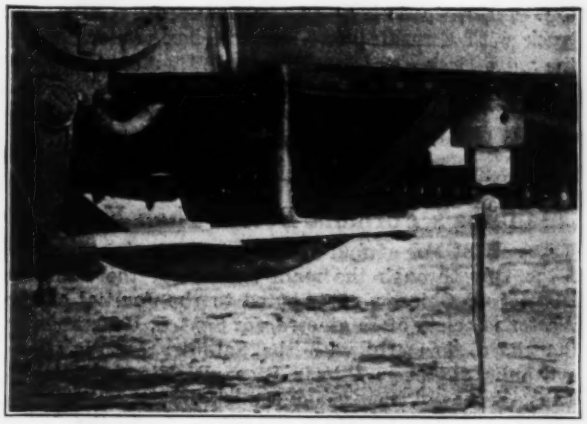


FIG. 2. POINTER FOR SPOTTING TRUCK OVER STREET BOX

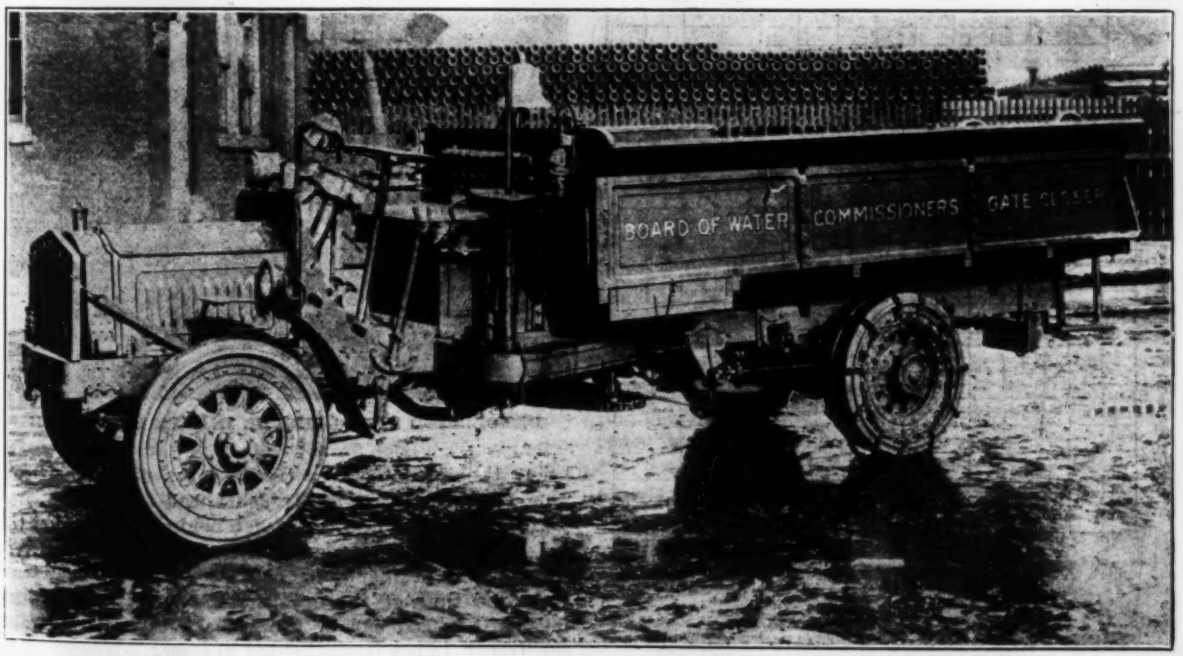


FIG. 1. MOTOR TRUCK WITH VALVE CLOSING MECHANISM, DETROIT WATER-WORKS

are carried in lockers in the truck body. Another truck with a repair gang and tool box trailer follows the valve closing truck.

George H. Fenkell is superintendent and general manager for the Detroit Board of Water Commissioners and W. M. Mitchell is assistant superintendent.

Manning's Formula Better Than Kutter's

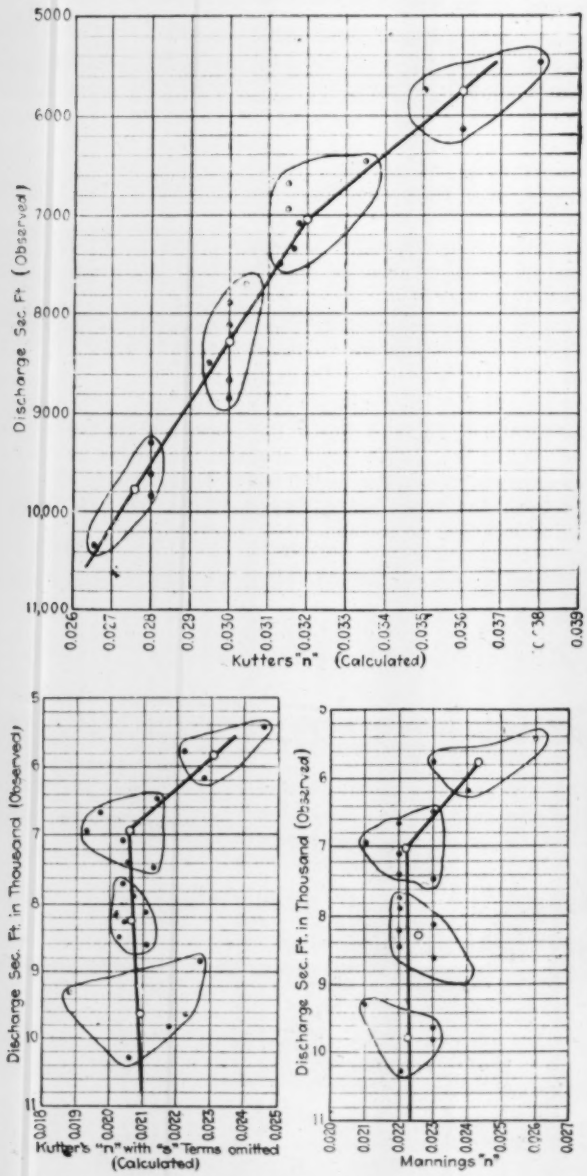
IN A RESUME of four years' intermittent gagings of the flow through the main channel of the Sanitary District of Chicago, contributed to the *Journal* of the Western Society of Engineers, for Sept. 5, 1920, Murray Blanchard, formerly with the Sanitary District, now hydraulic engineer, Illinois State Division of Waterways, Chicago, who made the study, concludes that Kutter's formula to obtain the value of c in the Chezy formula $V = c\sqrt{RS}$ will not apply. The value of n, computed and tabulated from measured discharges ranging from 5,000 to 11,000 sec.-ft. is not a constant but increases in value with the decrease in discharge, as shown in Fig. 1.

Similar computation for n with Manning's formula, which for c in the Chezy formula gives the following

$$c = \frac{1.486\,R^{\frac{1}{6}}}{n}$$

shows that n comes out a fairly constant value of 0.022 for all except the low discharge, as shown by Fig. 2.

H. W. King, professor of hydraulic engineering, University of Michigan, in commenting on Mr. Blanchard's work, suggests that an abbreviated form of the Kutter's equation, eliminating the s or slope terms, will give far more consistent results. Fig. 3, based on the Sanitary District records, gives for n a value somewhat less than 0.021. Professor King states further that for some time he has been of the opinion that Kutter's formula will give just as satisfactory results without the s terms. It is his opinion that the Kutter formula has been used satisfactorily for many years because, in most cases, channels are constructed with slopes so great that the value of c is not generally affected by the inclusion of the slope terms.



FIGS. 1, 2 AND 3. COMPARISON OF VALUES OF n CALCULATED FROM OBSERVED DISCHARGES IN MAIN CHANNEL OF SANITARY DISTRICT OF CHICAGO

What Can Happen to a Steam Shovel

BY GALE DIXON
Chief Engineer, Bureau Waterworks Improvement, Akron

THE accompanying photograph shows an accident to a steam shovel which occurred on our work at Akron several weeks ago. The shovel was working on a heavy timber mat over a trench for a 48-in. cast-iron pipe line, excavating the trench ahead of the mat and lowering the pipe into the trench behind it. The shovel rolled backward and as the wheel left the mat, the boom swung over onto the cab.

DEMOLISHED STEAM SHOVEL IN PIPE LINE DITCH

At the time of the accident the shovel was working at the head end of the trench, with six men in the trench immediately behind the mat. No one was hurt.

Nine Years' Operation of the Baltimore Sewage-Works

Plant Comprises Bar Screens, Venturi Meters, Hydrolytic and Separate Sludge Digestion Tanks, Imhoff Tanks, Sludge Drying Beds, Revolving Screens for Tank Effluents and Sprinkling Filters—Sludge Sold

By Theodore C. Schaetzle
Principal Sanitary Chemist of Sewage-Works, Baltimore, Md.

(Concluded from Last Week's Issue)

HERE at Baltimore, as well as at practically all disposal works, sludge disposal is of primary importance. As first designed three square digestion tanks of 609,000 cu.ft. capacity were provided. In 1914 sixteen additional tanks of the circular type, with a volume of 330,000 cu.ft., were built. A considerable addition to the sand bed area was likewise provided. However, the sludge has continued to accumulate at a faster rate than it has been disposed of, so that an addition to the digestion tanks is now under construction, while more beds will be provided in the near future.

Although troublesome at times, our sludge operation experience has been interesting. In the first years of plant operation there was plenty of storage capacity so that sufficient time could be allowed to produce well-digested sludge for disposal upon the sand beds. This sludge drained readily, dried and cracked well. During digestion the scum on the tanks formed from a few inches to approximately 2 ft. in thickness, but at no time prevented the normal operation of these tanks, which was as follows: The undigested sludge was pumped from the hydrolytic tanks into the digestion tanks, being delivered at one side and just beneath the surface. The digestion tank receiving the sludge would then lie undisturbed over night, during which period the water, which had been added to the undigested sludge during the pumping, would separate from the sludge and rise to a place just beneath the scum. From here the water was drawn off by means of a channel near the top of these digestion tanks and was disposed of in the idle hydrolytic tank or the one which had been in service the longest. This tank would then be ready to receive more undigested sludge or for the removal of some of the digested. The digested sludge was removed by opening one of the three well gates on the side opposite the incoming sludge. The sludge was drawn from the sloping bottom through any one of the three drain channels to a collecting well and from there through a drain to the pump well, from which place it was delivered to the sand beds.

It was noticed that certain parts of these tanks remained dead because there were only three draw-off points. To remedy this two of the tanks were emptied entirely and the drain channels covered with concrete slabs. Four lift gates were placed across the tank on each channel, making 12 in all for each tank. The idea was to raise by a chain that gate serving the part of the tank from which it was desired to draw the sludge. After the tanks were full and in operation unfortunately the gates could not be lifted by less than two men and, when once raised, it is doubtful whether they closed again.

In 1914 the scum had started to form from 2 to 2½ ft. in thickness and a hose was played upon the surface to break it up. This was unsuccessful as the area was so large that the force of the water was spent by the time it reached the center of the tanks. Sludge was continuing to form at an increasing rate and weather conditions prevented rapid drying on the limited sand bed area, so that when the new circular tanks and sand beds were completed in 1915 they were immediately pressed into service. In spite of this the sludge continued to accumulate and by the latter part of 1916 there was again need of more storage capacity. This seemed preferable to more sand bed area since the weather conditions regulate to a great extent the rate at which the beds can be cleaned and because the area then in use was about sufficient for the available laboring force even when the sludge was drying satisfactorily. Table II gives an idea of the sludge situation as it shows the total sewage flow for each year, the digested sludge produced and disposed of and the quantity in the tanks at the end of each year. The column of sludge disposed of gives the total, which includes that placed on sand beds, sold to farmers and placed on other areas.

TABLE II. DIGESTED SLUDGE PRODUCTION AND DISPOSAL AT BALTIMORE SEWAGE-WOKKS

		Cubic Yards of 90 per Cent Moisture Digested Sludge			
Year	Sewage Flow, M. G. per Year	Produced per M. G. (Based on Soundings)	Produced per Year	Disposed of per Year	In Tanks at End of Year
1912	4,320.85	1.52	6,568	No record	No record
1913	6,597.48	1.72	11,348	No record	No record
1914	8,372.09	3.85	32,233	24,981	15,168
1915	11,607.41	4.05	47,010	49,856	12,322
1916	14,374.00	3.69	53,040	45,760	19,602
1917	16,199.83	3.15	51,029	29,616	41,015
1918	19,284.78	3.32	64,025	39,103	65,937
1919	20,096.08	2.98	59,886	65,617	60,206
1920	19,074.23	3.00	57,223	57,214	60,215

More sludge was produced during the years 1916 to 1918 than was disposed of, and in consequence the quantity remaining in the tanks at the end of each year grew larger. The ultimate result has been a gradual change in the moisture content of the sludge. As previously stated, at first well-digested sludge was sufficiently watery to run freely from the tanks, while the scum formation varied from a few inches to approximately 2 ft. By 1914 the scum had reached 2 to 2½ ft. in thickness but it was still possible to remove well-digested sludge without the addition of water. By 1917 the surface scum, 1½ ft. thick, had dried to a moisture content of 69.9 per cent, with the next 2¾ ft. below containing 75.9 per cent water and the remaining depth sufficiently watery to run. However, the best digested sludge seemed to be in these top 4 ft., so that in order to place the best digested sludge upon the sand beds a 2-in. hose working under a 128-ft. head was used to break the surface up and mix it with the more liquid sludge. This gradual loss of water continued until the worst conditions for the large square digestion tanks was reached in October, 1918, whereas the circular tanks present their most difficult operation conditions at the present time. In fact the scum in some of the circular tanks is as much as 11 ft. thick. In October, 1918, soundings and analyses showed the moisture content of the top 2 ft. of the square digestion tanks to be 62.4 per cent, while the balance of the depth, or 11½ ft., except for small pockets of water, contained 78 per cent of water.

To relieve these conditions various available areas have been utilized by filling with sludge cut up with water. It was felt that more rapid progress could be made by removing the sludge without the addition of water. With this end in view a paddle conveyor, electrically driven, was put in service in April, 1918. For part of the time this removed the heavy sludge to the area adjacent to the square digestion tanks, from which place it was hauled away by the farmers, and for the balance of the time placed it directly into cars for hauling to the rotary drier plant.

In 1919 more sludge was disposed of than produced when the area between the filter beds and hydrolytic tanks was filled, thereby not only helping the sludge situation but improving the appearance of the grounds. The effect of this was noted in the soundings and analyses made in the large digestion tanks in October, 1919, when the scum moisture had increased from 62.4 to 69.8 per cent and the sludge beneath had increased from 78 to 79.9 per cent. During 1920, when the same amount of sludge was disposed of as produced, the moisture content of the scum and of the sludge beneath was further increased, so that on Oct. 1, 1920, the figures were 72.4 and 81.4 per cent respectively.

Since early in 1918 one of the most annoying features of the digestion tank operation has been the appearance of undigested sludge at the outlet end of the tanks. This has been accounted for by the fact that the raw sludge, as pumped into the digestion tanks at one side, found its way under the scum or through the heavy sludge, much as water does through a clay bank. However, the well-digested scum, when broken up and mixed with undigested sludge, has enabled the placing of at least partly digested material upon the sand beds at all times. For this purpose a 3½-in. fire-hose has been substituted for the former 2-in. one and is proving very satisfactory.

The operating force feels that when the excess sludge has been disposed of and sufficient storage capacity and sand beds have been provided for the current accumulation, so that the tanks can be kept with a scum not more than 2 ft. thick and the sludge with not less than 89 per cent water, the results will be very satisfactory, because past experience has shown that sludge digests well in the separate tanks.

One of the interesting features of the well-digested sludge is that it now contains 57 per cent volatile matter as compared to 44.2 per cent in 1914, when the tanks were operating normally and well. This change is probably due in part to the fact that in the early days of operation considerable mineral matter entered the sewers, due to the construction work then in progress.

The sludge as produced at this plant must be considered under four headings; namely, raw, separate digestion tank, Imhoff tank, and final settling basin sludge. An average analysis of these types is presented in Table III.

TABLE III. AVERAGE ANALYSES OF SLUDGE FROM DIFFERENT TANKS AT BALTIMORE

	Wet Sludge		Per Cent of Dry Residue				
	Per Cent Water	Specific Gravity	Volatile	Fats	Nitrogen	Total Phosphoric Acid as P_2O_5	Potash as K_2O
Digestion tank sludge	91.86	1.021	66.21	4.02	2.45	0.52	0.17
Imhoff tank sludge	92.38	1.017	62.74	....	2.75	0.58	0.19
Raw sludge*	79.16	.....	73.84	9.00	2.64	....	....
Settling basin sludge	92.37	.....	57.98	....	3.19	....	....

* Analysis as sludge exists in tanks before the addition of water for cleaning. As the raw sludge is being pumped into the digestion tanks the moisture content is 91.56 per cent and the specific gravity 1.020.

Sand Beds—The sludge is run onto the sand beds to a depth of 12 in. and when well digested cracks and drys rapidly in the summer, provided it is not an abnormally wet season. Ordinarily the beds drain well, but when one works to the contrary either of two methods is used to relieve the water. A man walks through the bed stirring up the entire mass or a small pipe is inserted at one or more corners of the bed to drain the water to the adjacent area. Then when the bed is empty the sand is loosened by raking.

In the years 1915 to 1920 inclusive 91,369 cu.yd. of dried sludge were taken from the beds and the beds were cleaned and refilled, on an average of 3¾ times a year. Calculating from the average of 3,326 cu.yd. per 1,000,000 gal. of 90 per cent digested sludge produced and 30,615 cu.yd. of 90 per cent sludge handled on the digestion-tanks sand beds yearly they have cared for the production of sludge from 9,205,000,000 gal. of sewage. At 100 gal. per capita daily, which is approximately our average, a yearly average of 252,192 people have been served by 5.06 acres of sand bed area during this five-year period. In other words, each person has required 0.874 sq.ft. of sand bed area per year.

Table III shows that the sludge from the digestion tanks as placed on the sand beds contains an average of 91.86 per cent water. The range of moisture, however, is from 86.6 to 96.4 per cent. That run from the Imhoff tanks ranges from 85.7 to 94.8 per cent moisture. When removed from the beds, the water content of the sludge ranges from 48.6 to 78.3 per cent, with an average of 68.7 per cent. In removing the sludge it is shoveled into cars and dumped in front of the Heineken Reduction Co.'s drying plant. From the beginning of operation to April, 1916, this material was placed in piles for future use in leveling off the grounds or for sale to the farmers. But on Feb. 1, 1916, a five-year contract was made for all sand-bed dried sludge so that since then the sludge has been dumped on this company's storage pile. The cars were formerly filled level full, removed from the beds by hand and then drawn by a mule to the dumping ground. The first part of this year a 22-hp. power gasoline engine was purchased for hauling. Now the cars are heaped and the engine hauls them directly from the beds, thereby giving a greater daily sludge removal.

Owing to the adherence of sand or gravel to the under side of the sludge when the latter is being removed the 4-in. beds need a renewal of the sand layer. A small amount of sand has been added from time to time, but it is fair to say that a total of 3 in. has been lost by all beds since 1915. The adhesion of sand or gravel to the sludge is a matter of considerable importance at the Baltimore sewage works because the sand bed dried sludge is sold under the above-mentioned five-year contract on the basis of its nitrogen content. If the sludge after passing through this company's rotary drier contains 2 per cent nitrogen as equivalent ammonia on the 10 per cent moisture basis, the city receives 81c. per ton, weighed with the water content ranging from 10 to 15 per cent. There have been times when the sludge has fallen below the required nitrogen content, the reason for which can be readily seen when it is realized that the mineral matter, principally sand, has run as high as 39.6 per cent. To overcome this difficulty one of the beds was partially covered with a slotted wooden

platform. This has been in service since 1916 and is still in good condition. It accomplished the purpose for which it was installed and the sludge disposed of upon it has acted very similar to that placed upon the sand direct. The present contractor for the sand-bed dried sludge does not seem disposed to renew his contract on the basis referred to above because he claims to have lost money during the past five years. Therefore efforts are now being made to form a new contract.

As removed from the beds the sludge has a specific gravity of 1.098 per cent, contains 70.67 per cent water, 54.83 per cent volatile matter, and 2.264 per cent nitrogen on the dry basis, whereas if analyzed at the time of removal, avoiding the sand, the figures are: Specific gravity, 1.077 per cent; water, 70.42; volatile matter, 61.76; nitrogen, 2.596 per cent on the dry basis.

Although the drying plant is not a part of the sewage-works proper regular analyses have been made of the moisture and nitrogen content of the sludge after drying. In brief, the process of drying is to feed the wet sludge into that end of the rotary drier at which the furnace is located. The heated air and sludge pass through the drier together and discharge into a dust box. From here the sludge passes to an elevated revolving screen which removes match sticks, corks, etc., and from here down through a chute, at the end of which it is bagged. An average of all the analyses made upon this material from April, 1916, when the contract started, to Dec. 31, 1920, is water 15.81 per cent and nitrogen on the dry basis 1.862 per cent. It is of interest to know whether there is any appreciable loss of nitrogen in passing through the drier. For this purpose a run was made in 1916 with the following result: Before passing through drier 72.50 per cent water and 2.111 per cent nitrogen on dry basis; after passing through drier 18.89 per cent water and 2.075 per cent nitrogen on dry basis.

Costs and Revenue—Excluding the cost of grounds, consulting engineers' charges and a proportion of the chief engineer's salary, the total construction cost of the Baltimore sewage works was $2,500,000, in round numbers. This does not include the cost of the alterations now being made to the Imhoff tanks.

The actual expenditures for maintenance and operation, exclusive of interest on investment and depreciation, have shown a gradual decrease in the unit cost of treatment for each year from 1912 to 1917. In the latter year, due to increased costs of material and labor, this price rose. Table IV and Fig. 3 show the average and maximum daily rate of flow for each year as well as the cost per million gallons for treatment. No maximum daily rates are available previous to 1914 and it might be said that the absolute maximum treated has been 106,090,000 gallons.

The Imhoff tanks began operating in August, 1915, and continued until June, 1917. They were idle, as previously stated, until May, 1919, when two were restarted experimentally. These two have been operating since and in addition 16 others were added during 1920.

The comparative cost of treating sewage in the Imhoff and in the hydrolytic tanks with sludge digestion in separate tanks is shown by Table V.

The large sum of $5,403 for the Imhoff tanks in 1919 is attributed to the fact that but two tanks were in operation and, being run experimentally, had more time applied to them per unit volume of sewage treated than would be the case under normal conditions. The additional increase for 1920 is caused by the increases given the laborers, to falling off in total flow and the necessity of disposing of a good proportion of the sludge both in the tanks and on the sand beds which had resulted from the period of operation in 1916 and 1917.

TABLE IV. MILLIONS OF GALLONS OF BALTIMORE SEWAGE TREATED DAILY AND COST PER MILLION GALLONS

Year	Average Daily Rate	Average Maximum Daily Rate	Cost of Treatment per Million Gallons
1912	11.80	.....	$4.860
1913	18.10	.....	4.800
1914	22.94	32.96	4.500
1915	31.80	42.90	3.450
1916	39.27	52.10	2.594
1917	44.38	59.15	2.882
1918	52.84	68.48	2.862
1919	55.06	71.83	3.389
1920	52.12*	69.97	3.902**

* The falling off in flow is due to the decrease in water consumption brought about by a campaign for conservation because of the danger of a water shortage.
** The increase in cost is due to the increase in labor costs and decrease in sewage flow.

TABLE V. COST PER MILLION GALLONS OF TWO METHODS OF TANK TREATMENT AT BALTIMORE

Year	Imhoff Tanks	Hydrolytic and Separate Sludge Digestion Tanks
1916	$3.630	$2.439
1917	3.933	2.841
1918	Imhoff Tanks Not in Operation	
1919	5.403	3.337
1920	6.897	3.738

TABLE VI. REVENUE FROM SEWAGE SLUDGE AT BALTIMORE

Year	From Farmers	From Drying Plant (By Contract)	Total
1914	$1 931.33	.....	$1 931.33
1915	2 242.75	.....	2 242.75
1916	1,098.15	$1,591.79	2,689.94
1917	346.40	28.07	374.47
1918	344.80	2,322.51	2,667.31
1919	309.00	1 557.61	1 866.61
1920	233.00	1 275.07	1,508.07

The cost per cubic yard of sludge removed from the sand beds with an average haul of 1,000 ft. was $0.292 in 1915, $0.292 in 1916, $0.374 in 1917, $0.382 in 1918, $0.454 in 1919, and $0.442 in 1920. In 1919, with the electrically-driven conveyor loading the cars at the digestion tanks and conveying the sludge direct to the dump, with a haul of 2,400 ft., the cost was $0.643 per cubic yard.

There has always been a small revenue from rentals of land and buildings, which will average approximately $900 yearly.

Since 1914 the bar screenings and sludge have been sold. The sludge has been sold both wet and dry; that is, in the same condition as when placed on the sand beds and as taken from storage piles after being removed from these beds. The price has been 25c. per load, except for a short interval, when it sold for 35c. This price was again reduced to 25c. per load after a falling off in sales proved that the farmers were unwilling to pay the 10c. increase. The wet sludge was removed in tank wagons holding approximately 250 gal., whereas the dried material has been sold by the load, one to two tons constituting a load.

In 1916 the sale of sludge to farmers was curtailed because the contract for sand-bed dried sludge began in the spring of this year. In 1917 it was still further curtailed by stopping the sale of wet sludge to those farmers who hauled over the main roads. Table VI shows revenue from the sale of sludge to the farmers and under contract.

In 1917 the revenue dropped exceptionally low, due to the fact that the drying plant burned down and practically all of the sludge which was dried ran below the

TABLE VII TO XI. AVERAGE MONTHLY ANALYSES OF BALTIMORE SEWAGE BEFORE, DURING AND AFTER TREATMENT, JANUARY, 1912, TO DECEMBER, 1920, INCLUSIVE

VII. RAW SEWAGE

Months	Chemical Determinations P.P.M. Suspended Solids	Settling Solids	Biochemical Oxygen Demand	Nitrates	Relative Stability Per Cent	Bacteria per C.C. Total on Plain Agar	Acid Forming
January	144	89	97	...	..	380,000	41,500
February	164	88	94	...	..	850,000	47,000
March	168	88	84	...	..	550,000	37,500
April	182	87	93	...	..	900,000	66,000
May	183	134	112	...	..	1,400,000	190,000
June	181	127	128	...	..	1,800,000	180,000
July	158	110	126	...	..	2,200,000	270,000
August	223	109	125	...	..	2,600,000	290,000
September	220	78	135	...	..	4,100,000	650,000
October	148	80	135	...	..	2,100,000	250,000
November	168	85	125	...	..	1,200,000	220,000
December	188	94	114	...	..	460,000	72,000

TABLE VIII. EFFLUENT FROM HYDROLYTIC TANKS

January	80	26	95	...	..	210,000	35,000
February	83	33	107	...	..	190,000	29,000
March	67	36	111	...	..	210,000	33,000
April	69	31	106	...	..	350,000	48,000
May	59	44	120	...	..	750,000	100,000
June	109	60	120	...	..	1,100,000	73,000
July	107	58	124	...	..	1,300,000	110,000
August	104	49	100	...	..	1,000,000	150,000
September	63	37	109	...	..	1,700,000	110,000
October	70	36	120	...	..	2,000,000	100,000
November	69	34	116	...	..	600,000	87,000
December	65	35	97	...	..	390,000	45,000

TABLE IX. EFFLUENT FROM IMHOFF TANKS

January	...	31	105	...	..	320,000	61,000
February	...	36	115	...	..	330,000	56,000
March	...	26	134	...	..	150,000	51,000
April	...	23	144	...	..	750,000	100,000
May	...	25	146	...	..	1,100,000	210,000
June	...	25	150	...	..	800,000	120,000
July	...	23	...	...	..	.....	.....
August	...	24	...	...	..	.....	.....
September	...	57	...	...	..	.....	.....
October	...	20	...	...	..	.....	.....
November	...	23	...	...	..	.....	.....
December	...	41	...	...	..	.....	.....

TABLE X. EFFLUENT FROM FILTER BEDS

January	60	56	37	5.2	81	53,000	5,800
February	73	46	40	5.4	82	140,000	9,900
March	63	45	35	6.8	88	49,000	5,600
April	93	67	34	8.0	94	140,000	9,300
May	67	40	29	11.3	95	260,000	18,500
June	96	52	32	8.7	92	700,000	23,000
July	65	52	36	8.1	91	440,000	31,000
August	58	44	26	8.0	96	470,000	35,000
September	37	29	30	6.5	93	650,000	75,000
October	48	32	30	6.7	98	270,000	28,000
November	59	44	36	7.6	96	140,030	17,000
December	96	54	40	6.1	83	88,000	14,000

TABLE XI. FINAL EFFLUENT

January	51	23	28	5.4	85	59,000	6,700
February	32	22	29	5.4	88	79,000	5,700
March	33	20	28	6.8	93	59,000	5,000
April	44	29	23	7.2	90	110,000	8,200
May	53	33	22	8.9	93	600,000	14,000
June	49	32	24	7.4	97	900,000	15,000
July	39	32	21	7.4	94	1,300,000	32,000
August	38	21	16	7.1	98	900,000	29,000
September	26	16	18	6.1	98	850,000	68,000
October	28	17	20	6.4	99	600,000	20,000
November	39	24	24	7.2	98	350,000	15,000
December	40	29	29	5.9	86	200,000	15,000

required 2 per cent equivalent ammonia content on account of the adhesion of sand and gravel in removing the sludge from the sand beds. Of the total output of this drying plant approximately two-thirds has contained the required amount of nitrogen and has therefore been paid for.

Plant Performance—Practically no mention has been made thus far of the analytical results of the sewage at its different stages of transit through the plant. While the routine analyses do not include total solids, chlorine, alkalinity and fats, an average for these is 773, 161, 153 and 81.7 p.p.m. respectively. The figure for total solids was obtained in 1916, at which time the suspended solids were 138 p.p.m. A 24-hr. run in February, 1920, gave an average of 17.8 p.p.m. free ammonia.

To acquire some knowledge of the performance of the plant during the various seasons the average of all results for the different months from 1912 through 1920 inclusive have been compiled and are presented herewith in Tables VII to XI. The yearly averages are given in Tables XII to XV. Table XVI presents the plant efficiency by showing the per cent reduction in solids, bacteria, and deoxygenating powers between the raw sewage and final effluent and by presenting the nitrates and relative stability of the final effluent, the raw sewage being practically devoid of oxygen in any form.

The final effluent of the plant during 1919 contained 2.50 p.p.m. dissolved oygen and had an oxygen consuming value of 25.3 p.p.m. by the permanganate method with a 30-minute digestion period. During 1916 the total solids were 616 p.p.m. and the suspended solids 47 p.p.m.

Samples of the river water are taken at fairly regular periods from April to December of each year. There are eleven stations, one approximately one-half mile up stream from the discharge pipe, another at the mouth of the discharge pipe, and the others down stream with a maximum distance of 9¾ miles below the outlet. The nearest oyster beds are 14 miles below the discharge. At all times since the plant operation began there has been a plentiful supply of oxygen at each station.

This summary would not be complete without some mention being made of the two most important experiments conducted at the disposal plant since its operation began, on activated sludge and grease recovery.

Activated Sludge—Under an agreement between the Sewerage Commission of Baltimore and the U. S. Public Health Service to work jointly on the activated-sludge process a series of laboratory experiments was started early in March, 1915, and continued until August of the same year. There were six experiments conducted simultaneously, five of which were with the air drawn through the bottle by means of an aspirator, while in the sixth the aërating was done by means of a propeller inclosed in a tube. The continuous operation of the latter experiment was broken up so often that reliable results were not obtained. The other five, run under different conditions, indicated that the activated-sludge process conducted under the fill-and-draw method was applicable to Baltimore sewage; that it was possible to generate sludge more quickly with mixtures containing final settling basin sludge than with raw sewage alone or raw sewage plus raw sewage sludge, and that the absence of light had no noticeable effect upon the activated-sludge organisms.

The large-scale experiment in one of the Imhoff tanks, altered for the purpose, was begun in the early part of 1915. The intention was to gain information as to the applicability and costs of the continuous-flow process. Although it was possible to get very well "activated" sludge with a sludge ratio as high as 30 per cent, a short time after a continuous flow of raw sewage was allowed to pass through the tank the sludge lost its oxidizing power. A number of changes were made because of mechanical difficulties and clogging of the air distributors. Finally, the best results were obtained by the use of the filtros disk grid. Unfortunately a fire destroyed the air compressor house on Feb. 15, 1916, burning practically everything, including the manometer for measuring the volume of air used. After this building was rebuilt experiments were started with another

TABLES XII TO XV. AVERAGE YEARLY ANALYSES OF BALTIMORE SEWAGE BEFORE, DURING AND AFTER TREATMENT, 1912 TO 1920, INCLUSIVE

TABLE XII. RAW SEWAGE

	Chemical Determinations, P.P.M.					Bacteria per C.C.*	
Year	Suspended Solids	Settling Solids	Biochemical Oxygen Demand	Nitrates	Relative Stability Per Cent	Total on Plain Agar	Acid Forming
1912	54	...	...	...	..	*1,900,000	56,000
1913	122	...	115	...	..	1,700,000	360,000
1914	120	...	131	...	..	2,300,000	150,000
1915	256	183	113	...	..	1,100,000	160,000
1916	138	102	91	...	..	1,100,000	89,000
1917	260	69	90	...	..	950,000	59,000
1918	287	49	127	...	..	800,000	40,500
1919	111	66	171	...	..	1,400,000	160,000
1920	172	120	...	...	..	2,200,000	320,000

* Gelatin count at 20° C.

TABLE XIII. EFFLUENT FROM HYDROLYTIC AND IMHOFF TANKS

1912	31	...	...	...	..	.....	.....
1913	76	...	129	...	..	1,300,000	310,000
1914	85	...	190	...	..	3,300,000	230,000
1915	109	58	153	...	..	1,100,000	210,000
1915	...	*55	...	...	..	.....	.....
1916	...	35	118	...	..	800,000	94,000
1916	...	*26	*132	...	..	*550,000	*100,000
1917	...	34	135	...	..	850,000	70,000
1917	...	*21	...	...	..	.....	.....
1918	...	36	114	...	..	850,000	63,000
1919	...	37	93	...	..	700,000	66,000
1920	...	39	92	...	..	650,000	93,000
1920	...	*28	...	...	..	.....	.....

* Imhoff results.

TABLE XIV. EFFLUENT FROM FILTER BEDS

1912	22	...	30	8.3	98	.....	.....
1913	56	...	30	8.2	91	180,000	36,500
1914	60	...	41	7.2	78	470,000	35,000
1915	89	68	37	6.2	87	250,000	31,000
1916	...	48	33	4.4	93	290,000	12,000
1917	...	49	38	7.4	92	200,000	12,000
1918	...	40	32	8.1	96	160,000	7,700
1919	...	46	31	7.7	89	190,000	9,300
1920	...	27	27	7.0	92	150,000	13,000

TABLE XV. FINAL EFFLUENT

1912	13	...	...	7.5	98	.....	2,400
1913	22	...	13	7.9	99	260,000	16,000
1914	37	...	26	6.9	92	700,000	24,000
1915	43	28	21	5.5	94	750,000	25,000
1916	47	31	22	4.1	92	750,000	11,500
1917	42	27	28	7.4	92	330,000	11,500
1918	46	25	26	7.6	95	500,000	8,500
1919	43	24	24	6.7	92	250,000	13,500
1920	41	18	25	6.5	90	230,000	19,000

TABLE XVI. AVERAGE YEARLY EFFICIENCY RESULTS BALTIMORE SEWAGE-WORKS. 1912 TO 1920 EXPRESSED AS PERCENTAGES FROM ROW SEWAGE TO FINAL EFFLUENT

	Percentage Reduction				Increase in	
Year	Suspended Solids	Settling Solids	Biochemical Oxygen Demand	Acid Forming Bacteria	Nitrates p.p.m.	Relative Stability Per Cent
1912	75.5	....	....	95.8	7.5	98
1913	82.3	....	88.9	95.6	7.9	99
1914	69.0	....	80.0	84.2	6.9	92
1915	83.2	84.7	81.4	84.4	5.5	94
1916	65.9	69.6	75.3	87.1	4.1	92
1917	83.9	61.4	68.9	80.6	7.4	92
1918	84.7	50.4	61.2	79.0	7.6	95
1919	61.3	64.3	81.2	91.6	6.7	92
1920	76.2	85.1	85.5	94.1	6.5	90
Averages..	75.8	69.3	77.8	88.0	6.7	94

Note: Raw sewage practically devoid of oxygen in any form.

type of blower. This blower did not perform satisfactorily and in consequence the laboratory analyses were discontinued on May 19, 1916. Efforts to adjust the blower difficulties continued until the fall of 1916, when the experiment was stopped. There is no account of the exact reason for discontinuing the activated-sludge experiments, but the most reliable information is to the effect that the lack of funds was the cause. More extensive data on the Baltimore experiments can be found in *Engineering Record*, April 24, 1915, p. 521, and July 3, 1915, p. 23; *Engineering News*, July 22, 1915, p. 164, April 27, 1916, p. 798, and July 20, 1916, p. 106, and in the *Municipal Journal and Engineer*, Oct. 19, 1916.

Grease Recovery—Beginning in June 1915, and continuing approximately five months, an investigation was conducted at the Baltimore sewage-works by G. J. Requardt, formerly acting division engineer, and Arthur B. Merrill, formerly chemist-bacteriologist, to determine the feasibility of extracting fats and grease from the city sewage.

The large-scale experiment consisted of pumping the sewage continuously from the outfall sewer into a cylindrical tank of 428 gal. capacity at the rate approximating a 5-hr. detention period. Enough sulphuric acid was constantly added to the inflowing sewage so that the effluent was always acid. A number of small-scale experiments, somewhat similar to the tank experiment, were conducted in the laboratory. In the latter enough sulphuric acid was added to the sewage so that it remained acid after 3 hr. settling.

The results of these experiments show that the value of 30.9 grams per capita is reliable for the *total* amount of grease in Baltimore sewage, that the sludge accumulated in the large tank experiment contained on the dry basis 27.5 per cent of grease, of which 86.34 per cent was saponifiable and 13.66 per cent unsaponifiable. The sludge obtained had a very objectionable odor, contained 93.9 per cent water, and dried on the sand bed much less readily than good non-acidified sludge. Even after 48 days drying it retained 66.8 per cent moisture.

Grease Recovery

At the conclusion of this work correspondence with six different manufacturers revealed the fact that only one would consider the use of the grease produced, and his requirements as to purity and per cent of water made the cost prohibitive.

The mechanical recovery of the floating grease by skimming and then applying heat and straining produced a substance with a distinct sewage odor and with such an amount of water that it was practically impossible to find a market for it. For this reason nothing further has been done along these lines.

When the work of The Sewerage Commission ended in the early part of 1916 the sewage-works was put under the supervision of the Highways Engineer's Department, of which A. E. Christhilf is the present head, with Milton J. Ruark in direct charge of the sewer division, and J. J. Holden superintendent of the plant.

Drainage Work in the Florida Everglades

Construction of lateral ditches as well as of main canals by the Everglades Drainage District is probable, according to a paper read before the Florida Engineering Society by the chief engineer of the district, F. C. Elliot, Tallahassee, Fla. An extract from that paper is given below:

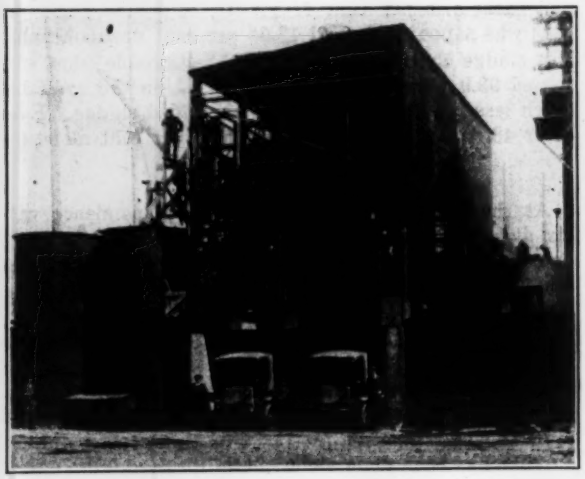
The main drainage canals extending through the Everglades, with their main controlling works, together with the control of Lake Okeechobee, constitute the work in general being provided by the Everglades Drainage District. Lateral ditches comprising the secondary system are left to each particular locality to construct at the time and in the manner convenient to such locality. But conditions appear to be developing which may make advisable the carrying out of the secondary system also by the District, for the purpose of insuring a properly co-ordinated system of both main and lateral canals for effective and satisfactory drainage. The reason for this is a very general lack of knowledge on the part of landowners as to the necessity of any sort of lateral or farm ditch system for securing local drainage and for supplementing the main canal system.

New Philadelphia Asphalt Plant Has 4,000-Sq.Yd. Daily Capacity

City-Owned Installation One of Largest in Country —Modern Mechanical Devices a Feature

By H. T. MacFarland
With Barber Asphalt Paving Co., Philadelphia

ASSUMPTION of responsibility by the city of Philadelphia, Pa., for the maintenance of 621 miles of sheet asphalt pavement and the 115.3 miles of bituminous country road, coming shortly after the highway bureau of the department of public works had taken over the cleaning of streets and collection of refuse in several selected trial districts, has resulted in the construction of a municipally-owned asphalt plant, completed last March. Asphalt pavements in Philadelphia represent more than 50 per cent of the total improved thoroughfares. The new plant, which will be used, at least for the present, exclusively on repair work, has a rated daily capacity of 3,700 sq.yd. of finished sheet asphalt



DUPLICATE INSTALLATION ALLOWS SIMULTANEOUS LOADING OF TWO TRUCKS

topping, but will produce in excess of 4,000 sq.yd. of this material per day. The output of binder and of bituminous concrete will run 50 per cent in excess of the rated capacity for sheet asphalt. The Philadelphia plant is one of the largest city-owned installations in the United States and in point of mechanical equipment is the most modern.

Decision to install a municipal asphalt mixing plant was made by city officials only after a comprehensive view of the street repair situation in Philadelphia, and of the experiences of other cities which have their own plants. Heretofore repair work, like the laying of new pavements and the resurfacing of highways, had been done under the contract system. The operation of the municipal plant is expected to result in substantial economies, as well as greater mobility of the repair forces.

In the city plant are embodied the latest devices for the handling of crude materials and the efficient and economical production of asphalt pavement mixtures. The plant is located on the Delaware River at Fairmount Ave. Slips on each side of the narrow strip occupied by the plant provide adequate space for four or more barges, which will be utilized to bring sand from the New Jersey banks and stone and other materials where water transportation is most economical. Spurs from the Belt Line Railroad, over which cars of all lines are routed, lead into the plant, so that asphalt and fuel oil can be pumped directly from tank cars into the storage tanks provided. Limestone dust and other materials also will be transported by rail and unloaded directly into storage bins or rooms. From the plant trucks can be dispatched to all parts of the city by direct routes.

The mixing plant proper, supplied by the Barber Asphalt Paving Co., consists of two 1,850-yd. Iroquois straight-line stationary plants, set up side by side. Each unit can be operated separately, one, for instance, turning out binder and the other sheet asphalt topping or asphaltic concrete mixture. Each has its own operating platform, its own elevators and discharging points, so that two trucks can be loaded simultaneously. Storage tanks, heating kettles, storage bins and all other units are grouped near the mixing plant, with derricks and other apparatus conveniently located.

Along the left hand slip is a large reservoir bin, capable of holding two barge-loads of sand. The material is unloaded by an electrically-driven derrick, equipped with a 1½-yd. bucket. The derrick carries a 70-ft. boom, with a working area of 270 deg. It is proposed to bring all sand to the plant by barges, since the New Jersey banks are readily accessible to water transportation. Stone and dust will be delivered by rail. A second derrick, located in the center of the yard, will be used to unload cars and transfer sand from the reservoir bin to the storage bins in the rear of the mixing plant. When operating between reservoir and storage bin, at a fixed angle of 45 deg., it will transfer a bucket of sand every minute.

The battery of three storage bins, or operating bins, is located directly in back of the mixing plant. The center bin holds 75 cu.yd. of stone and each of the two end bins, 100 cu.yd. of sand. All three bins are 22 ft. in height, and 16 ft. x 16 ft. in plan. The storage bin walls are made of tongue and groove 2-in. yellow pine, 10 in. wide. The inside walls of the reservoir and storage bins were treated with a special creosote paint by the penetration method, the storge bins being given four coats.

Limestone dust is handled in bags. The plant is equipped with dust collectors to reduce the dust nuisance. Engineers make their determination before the material goes into the dryer, and after the sand is heated the dust is put back.

Oil burners are used for heating the dryer, but the system is a duplex one, so that coal can be burned if desired. A 100-hp. boiler is used for heating steam coils and for operating the oil and other pumps. It is equipped to burn oil.

When delivered in tank cars, the asphalt is transferred by pumping to four storage tanks with a capacity of 10,000 gal. each, located alongside of the tracks. Asphalt from the storage tanks is pumped to the heating kettles. The storage tanks are in series, and one or more can be cut out when necessary. They are lined with coils, the lower or agitation coils being 1¼ in. Above the agitation coils are two horizontal grids and, vertically, 3 spiral helixes. In the storage tanks the asphalt is raised to a temperature of 250 deg. F.

Four steam heating kettles of 4,000-gal. capacity each are employed to raise the asphalt to the proper tempera-

before it is lifted to the mixer. They are equipped with horizontal steam coils. All asphalt lines are steam-jacketed.

The two mixing plants are identical in construction. The units of each plant are operated by one shaft, clutches being provided for engaging the different units. A 125-hp. motor, current for which is furnished by the local service corporation, operates the drive. One notable feature of the plant is the compact arrangement with all parts on a single frame holding shafts, gears and other units in line. The plant can be operated with a minimum force, due to the convenient arrangement of levers engaging the units and controlling loading, mixing and discharging.

The cold material elevator is on the rear of each unit, operating directly between plant and storage bins. Each line of elevator buckets can handle 12 cu.ft. of materials per minute.

The heating drums in the two units are 20 ft. long by 48 in. in diameter. They are of the revolving type and made of heavy steel plate, with short channel flight

PHILADELPHIA ASPHALT PLANT, SHOWING LAYOUT PRIOR TO HOUSING IN

inside for elevating and spilling the materials. A roller chain drive is used. An air exhaust fan produces the necessary drum stack draft, while the piping carries the dust from the fan to the collector overhead. Two fuel-oil burners are used under each drum.

The units are equipped with two-section revolving screens for fine and coarse material, covered with steel hoods. The storage bin, of steel plates with two compartments, is equipped with a tailing pipe connected with the screen and with an overflow pipe leading to each compartment. There are separate discharge gates and operating levers for each compartment.

The weighing box, located within easy reach of the operator, is equipped with a steel gate at the bottom and operated with a lever. It is supported by an automatic three-beam enclosed platform scale. Beside it is the revolving-type asphalt bucket, suspended on a two-beam scale.

The mixer is of the two-shaft pug-mill type with a capacity of 12 cu.ft., steam-jacketed and steam dumping. It is equipped with universal blades suitable for any mixture. A roller chain furnishes driving power.

Each plant is equipped with a steam-jacketed pneumatic asphalt lift, air compressor, air receiver tank and piping for lifting the asphalt from the kettles to the weighing bucket.

Beneath the plant is a small room, where limestone dust will be fed into the elevator, and a larger dust storage room. The plant siding runs past the door of this room, so bags can be unloaded direct from cars.

The plant housing, erected around the assembled plant, is of corrugated sheet asbestos with steel core. The framing is of steel.

For the storage of fuel oil, a tank with a capacity of 15,000 gal. has been installed at the river end of the yard. The oil will be pumped direct from cars into the tank, which is surrounded by a concrete wall.

Repair Service

Thirty men have been employed in the crew at the new plant. "Jitney gangs," or small groups of workers, who will be dispatched to various sections of the city to make minor repairs as soon as such pavement defects are reported, will form one feature of the service. Other gangs numbering more than 100 men will be scattered over the city and assigned particular territories to keep in repair. The city officials hope eventually to develop the service to a point where each gang will be held strictly responsible for prompt repairs and the maintenance of every asphalt street and road in first-class condition.

Motor trucks and other equipment for repair work have been provided by the city. A large garage is to be erected on a city-owned lot directly opposite the asphalt plant, so that there will be no delay in repairing or starting out the trucks. Delaware Avenue, with a width of 80 ft., offers ample facilities for the parking and turning of trucks.

The installation of the city asphalt plant marked one of the constructive works of his administration, Mayor J. Hampton Moore declared recently, when receiving the plant on behalf of the city. The completed plant represents an expenditure of approximately $110,000.

The plant was installed under the supervision of Frank H. Caven, director of public works, and Fred C. Dunlap, chief of the bureau of highways. The latter official played an important part in working out the arrangement of the units, and is largely responsible for the efficient location of plant, bins, spurs and other equipment. Fred Roth was construction engineer in charge of installation.

Control of British Waterways

London Correspondence

Group control and organization of the inland waterways system in England is recommended in a second interim report issued by the Departmental Committee appointed by the Minister of Transport to inquire into the development of the canal and waterway system and occasioned by the advancement of the British Railways Bill. Group organization is recommended in lieu of the program dealing with the whole system of canals comprising what is known as "The Cross," or the entire system connecting north and south, and east and west, proposed by the Royal Commission. It is recommended that the groups be set up gradually, and as a start it is suggested that the River Trent be made the central route of the first group, with its organizaion to be undertaken without delay. It is intended that each waterway group shall be controlled by a trust, including representatives of the various parties at interest, such as traders and local authorities, and the state should state money be involved.

Boston Engineers Report Against Licensing Law

AN ADVERSE REPORT to passage of the engineers' registration and licensing law, still pending before the Massachusetts Legislature, has been made by a joint committee of engineering societies and local sections, reporting to the combined membership. The bill had previously been opposed by the joint committee on licensing and the recent report reviews reasons for the conclusion reached. It is signed by twelve of the thirteen members of the committee.

A petition was filed in the Legislature, Jan. 4, 1921, by the Boston Chapter of the American Association of Engineers, accompanied by a bill to provide for the registration of professional engineers and land surveyors. On Jan. 7 the joint committee on licensing resolved that legislation on this subject by the present session of the legislature should not be recommended, at the same time requesting the Boston Chapter of the A. A. E. to withdraw its petition for legislation. The joint committee now reports that it is opposed to the passage of the proposed law, not only for the reason that it contains "many glaring defects and inequalities," but also because existing laws, as in the case of building codes, etc., appear to offer adequate protection in such cases. There would also be a tendency through licensing to place the inexperienced man, in the eyes of the law and the public, on a plane with the experienced engineer of higher professional attainments. Extracts from the recent majority report of the joint committee follow:

The life, the health and the property of the public, it was claimed [by the proponents of the bill] were in the hands of the engineers who were responsible for the structures and public works that the people use or enjoy and it was stated that existing laws did not sufficiently protect the public in these directions.

Existing Safeguards Adequate

Prof. George F. Swain pointed out at the hearing the character and extent of the safeguards to the public that exist in the construction of buildings, public and private utilities, etc., through supervision by competent commissions and engineers, through building laws and other special laws requiring official supervision and approval of plans, inspection of work in process and of finished work. He expressed the opinion that if such measures were not sufficient the wise policy would be to add to them and to amend them in such a way as to cure their defects, but that no possible method of registering engineers could take their place or could provide a system of safeguards to society that was comparable with them in effectiveness.

An engineer is not usually chosen in a hurry or for work of an emergency nature, and in engaging an engineer to design engineering work of greater or lesser importance, a client now considers the professional reputation and work accomplished by the engineer whom he is to employ. Public or private interests are better safeguarded by such practice than by selecting an engineer by virtue of his holding a license.

It was demonstrated at the hearing under the proposed bill that a person who became registered, through society membership or otherwise, would be in the eyes of the law, fully competent to practice every branch of engineering, regardless of the field in which his training or experience had been. A system of licensing which provides for competency in one field may open up an opportunity for incompetence in others.

It is an open question as to what extent licensing laws should go in the registration of applicants; if the requirements of the examining board call for professional attainments of the highest order, the result would be public confidence in a registered engineer. If licenses are issued to men of mediocre or inferior ability, many would obtain licenses and have the same standing before the public as those of much greater professional attainments and reputation, with the result that public and private interests would suffer from work of inferior character.

What is an engineer? One of the greatest difficulties in licensing engineers is deciding this question. Some laws define an engineer or engineering; others avoid it entirely, leaving it in case of litigation or similar difficulty for the courts to decide. If engineers themselves, in framing laws for registration, cannot define what an engineer is, it can hardly be expected that the courts, which are dependent in technical questions upon expert testimony, can prepare a suitable definition of engineering. There have been many attempts so to define the profession and with indifferent success. Many such definitions specify special branches and wind up with a blanket clause at the end to cover all other branches of engineering, with the result that the branches of the profession previously designated might as well be omitted. It is a question how laws can be framed effectively and properly to regulate anything that cannot be definitely and comprehensively defined.

Universal Licensing of Specialists

In this connection, it is difficult to comprehend how a man registered as an engineer and whose principal knowledge is confined to, say mechanical engineering, is any more qualified to pose as a chemical engineering expert than would be a lawyer, a physician or a plumber for instance, or a person skilled in many other professions or trades, provided their general educational qualifications correspond.

Laws for the licensing of engineers should also include the licensing of architects and affiliated professions, for the reason of the two professions being so closely interwoven that they are mutually interdependent in many ways.

Edwin H. Rogers, Boston Society of Civil Engineers, city engineer of Newton, Mass., is chairman of the joint committee, consisting of six members of the Boston Society of Civil Engineers and one member each representing the following: Boston Section, American Institute of Electrical Engineers; Boston Section, American Society of Mechanical Engineers; Boston Society of Architects; Boston Section, American Society of Heating & Ventilating Engineers; Boston Section, American Institute of Mining & Metallurgical Engineers; Boston Society of Landscape Architects, and Boston Chapter, American Association of Engineers. The report is not signed by the representative of the A. A. E. chapter.

It is stated in the recent majority report of the licensing committee that the demand for licensing or registering engineers in the locality of Boston, so far as they have been able to observe, appears to have come entirely from the American Association of Engineers. It is further stated that "this evidence is further confirmed by the introduction of bills for licensing or registering engineers in practically all the states of the Union and by the active campaign in support of these measures during the present year, in all states in which such laws had not already been passed, by the American Association of Engineers.

"It appears to be the fact that these petitions for registration in all the different states contain the proviso that membership in the American Association of Engineers and in certain other professional societies shall be a sufficient requirement for registration as an engineer."

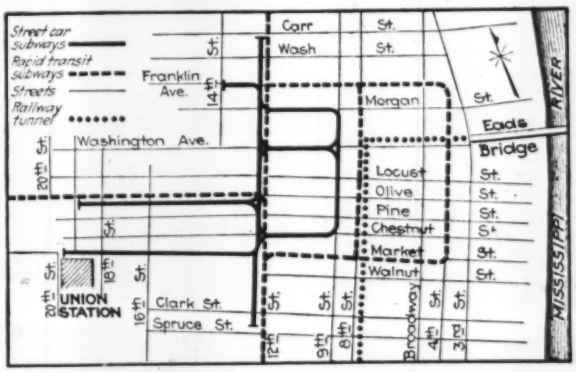
Opposition to the licensing bill at hearings last February appeared so strong that it resulted in the recommendation by the legislative committee that the bill be referred to the next annual session of the Legislature. This recommendation was adopted by the Senate, Feb. 24, 1921, and subsequently by the House.

Street Railway and Rapid Transit Plans for St. Louis

Systematic Linking of Car Lines to Serve for Ten Years, with Downtown Subway—Future Rapid Transit System

IMPROVED transportation service and a more equalized growth of the city are the objects sought by a reorganization of the street-railway system of St. Louis, Mo., as proposed by the City Plan Commission and explained in a report by Harland Bartholomew, engineer for the commission. Two main problems of the immediate future are the relief of congestion in the business district and the provision of more direct routings to all parts of the city. The following matter is a brief abstract of the report.

A single company now operates the entire street railway system, but franchise requirements and mortgages on various original lines have made it necessary to continue operation of certain routes. This results in inefficient and uneconomical service and is one cause of the present company having gone into the hands of the receiver in April, 1919. It is hoped that with the termination of the receivership there will come a company able and willing to meet the city's needs, and it is on this condition that the proposed plans are based. Interurban lines from the west are operated by the same company as a part of the city service;



PROPOSED STREET CAR AND RAPID TRANSIT SUBWAYS FOR ST. LOUIS

independent lines entering from the east do not penetrate far enough into the city to affect the street railway system, except as to terminal facilities.

A determining factor in the proposed plan of a more systematic arrangement of the street railway lines was the city's policy of opening, widening and extending numerous streets, which will facilitate more direct routing and quicken operation of individual lines. Unnecessary duplication of lines in many places and a lack of direct north and south routes are defects which mark the present system and which it is planned to eliminate by connecting and extending various lines and removing others which help to increase rather than to relieve congestion.

As the city is in the form of an ellipse, with its business district at the outer edge, the traffic haul is larger than if this district were at the geographical center. Hauls of five or six miles are the rule rather than the exception. This condition is made more objectionable by the fact that nearly 50 per cent of the distance is through deteriorated sections which are almost unremunerative from the traffic point of view. With the present street system more direct routings are available to the west than to the north or south, but the narrow and crooked streets which have made travel relatively slow in the latter direction are now being widened and straightened under plans developed by the City Plan Commission (see *Engineering News-Record*, May 13, 1920, p. 954).

The great majority of the people live within the 35-minute time zone from the center of the city (8th and Olive Sts.), but with the improved street railway layout about 11 sq.mi., 18 per cent of the city's area, will be added to zones from which this point can be reached in 35 minutes or less. At present 21 per cent of the city's area is more than ½-mile from a car line, excluding river-front areas, but with the new plan this would be reduced to 3 per cent.

Subways and Rapid Transit

With the proposed extension and rerouting of the street railway service, the needs of the city may be served without serious inconvenience for at least ten years, so that independent rapid-transit facilities are not needed at this time. In fact, there is not now a sufficiently great movement of people in any one direction to warrant the establishing of such facilities. Furthermore, a rapid-transit system at this time would be detrimental to the proper growth of the city, as it would tend to encourage the shift of population to the outer suburban districts and thus lessen the usefulness and value of the intermediate areas, whereas the city needs greater intensity of development within these latter areas before a rapid-transit system will be justified. In fact, while suburban districts are now being developed there is no substantial development of the "blighted districts."

On the other hand, removal of certain transit lines from the surface of the narrow streets of the business district will soon become an urgent necessity. The rush hour movement in St. Louis is rather heavier than in other cities, but with the increased crowding of these narrow streets by automobiles it is almost impossible to meet the demands of the evening rush hour within this district.

A subway loop is suggested, therefore, for all east and west lines across the business district, as shown by the accompanying plan. This subway would be about 25 ft. wide and 14 ft. high, with its roof as close as possible to the street surface. Stations would have platforms with stairways to the sidewalk. The eastern or downtown side of the loop is placed on 9th St. in order to avoid interference with the steam railway tunnel on 8th St., connecting the Eads Bridge with the union station.

Subway loops for rapid transit lines independent of the street car lines will be necessary eventually, but these must be distinct from the street car subways and are planned as shown on the drawing. As these later subways would intersect the present railway tunnel, alternative plans for the latter are suggested: (1) That railway traffic be diverted to the Municipal Bridge and the lower (railway) deck of the Eads Bridge be given up to rapid transit purposes; (2) that a new railway tunnel be built on 3d St., outside of the subway district, in which case the present 8th St. tunnel could be utilized as a rapid transit subway.

Rapid transit service beyond the subway district is provided for in the plans by four elevated lines, two running west and the others northwest and southeast respectively. These would be concrete structures spanning the street car tracks, except that the one on the private right-of-way of the Hodiamont line would be a solid fill with concrete retaining walls and street bridges.

In 1920 the estimates of cost were $17,000,000 for the street car subway and $17,000,000 for the rapid transit subway or $80,000,000 for the complete rapid transit system, including elevated lines and subways. This would mean $97,000,000 for relieving the street congestion and providing rapid transit facilities, but, as stated already, the latter facilities will not be needed for several years if the surface lines are developed on the proposed plan.

Rotterdam Floating Drydock

The port equipment of Rotterdam has been increased through the construction of a large floating drydock put into commission within the past few weeks, according to *Commerce Reports*. Its first service will be the overhauling of the Holland-American liner "Rotterdam." The dock has a length of 692 ft., an outside width of 167 ft. and an inside width between fenders of 137½ ft. It has a lifting capacity of 46,000 tons.

Fire Resistance of Building Columns as Shown by Test

Conclusions Drawn From Test Series of 106 Columns—Cast Iron and Timber Resist Longer Than Unprotected Steel—How Various Fireproofing Materials Fail—Concrete Makes Best Showing

By R. E. Wilson
Engineer, Associated Factory Mutual Fire Insurance Co., Boston

A SERIES of elaborate tests to determine the fire resistance of bare and fireproofed building columns was carried out during 1917 and 1918 by the Associated Factory Mutual Fire Insurance Cos., the National Board of Fire Underwriters, and the U. S. Bureau of Standards. A special furnace and testing machine combined was built for the work at the Underwriters' Laboratories, Chicago, by which a column could be subjected to heat while under full load. Because of the large amount of data involved, the results have only just become available, through a detailed report published jointly by the three co-operating organizations. In order to make the results of this important investigation available for use by structural engineers and architects, an analysis is presented herewith in brief form. The conclusions expressed are supported not only by the data given in the full report, but also by the writer's observations as a member of the test party.

FIG. 1. FIREPROOFED COLUMN IN FURNACE WITH PYROMETER COUPLES AND DEFORMETER IN POSITION

The motive for undertaking the tests was the realization that authoritative information on the resistance of building columns to fire exposure was very limited, and that this produced much uncertainty concerning safe methods of construction, reflected in wide variations in building code requirements. Recognizing the need of dependable data on this subject as well as a more accurate basis for determining the value of different types of construction from an underwriting standpoint, the Associated Factory Mutual Fire Insurance Cos. in 1910 proposed that a series of test be made, and secured the co-operation of the National Board of Fire Underwriters, through the Underwriters' Laboratories, and, four years later, of the Bureau of Standards. Preparatory work, including the construction of the furnace and testing machine, began in 1912.

Design of Columns—The essential feature of the tests was to subject the columns to full fire exposure *while under working load.* The furnace and the hydraulic loading ram designed for this purpose are shown in Figs. 1 and 2.

In all, 106 tests were included in the series; 91 of these were first tests only, while in the remaining 15 tests hose streams were directed against the columns when they were at high temperature. All the columns had an effective length of 12 ft. 8 in. and were designed for a working load of approximately 100,000 lb. as calculated by the following formulas, which are generally accepted in good engineering practice for the various materials: Steel columns, $16{,}000\text{-}70l/r$; cast iron, $10{,}000\text{-}60l/r$; Lally columns (steel pipe filled with concrete), $A_s(13{,}500\text{-}140l/d + A_c(1{,}000\text{-}11l/d)$; vertically-reinforced concrete columns, $450\ (A_c + 15A_s)$; hooped concrete columns, $650\ (A_c + 15A_s)$; timber columns, $1{,}000\ 1\text{-}l/80d$). Both in length and capacity the columns were thus representative of interior columns used in buildings of moderate height.

Type and Protection—The specimens in the fire series consisted of: (1) Unprotected structural steel columns (rolled H, plate and angle, plate and channel, latticed channel, Z-bar and plate, I-beam and channel, latticed angle, starred angle); (2) unprotected round cast-iron columns, vertically and horizontally cast; (3) Lally columns (concrete-filled steel pipe); (4) unprotected timber columns; (5) steel columns partly protected with concrete; (6) protected columns of the various types, with both single and double coverings of metal lath and plaster, and with 2 in. and 4 in. thicknesses of concrete made with different kinds of aggregates, hollow tile of different kinds of clay, and solid gypsum block; (7) reinforced concrete columns with 2 in. integral concrete protection.

The columns and covering materials were obtained from various sources in different sections of the country, including the Chicago, New York, Boston, Cleveland and St. Louis districts, in order to secure samples which were fairly representative of the material used in building construction of the various classes. A large number of auxiliary tests were made on samples of all materials used. The materials of which the columns were constructed generally conformed to accepted specifications for the various kinds of structural material. The steel columns were detailed and fabricated in accordance with good engineering practice. The placing of the various coverings was generally done by experienced workmen in the several trades and the workmanship obtained throughout was fairly representative of that secured in good building practice. All concrete was mixed in a batch mixer. The columns were stored in the testing room and the age of the coverings at time of test ranged between 13 and 18 months.

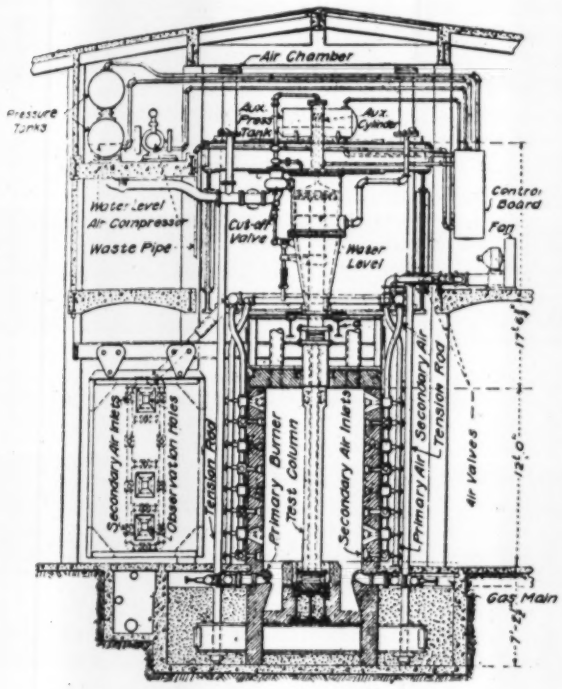


FIG. 2. GENERAL DRAWING OF FURNACE AND TESTING MACHINE

Manner of Testing—With the exception of three cast-iron columns the steel, cast-iron and reinforced-concrete columns were tested with upper ends fully restrained and lower ends partly restrained. The remaining cast-iron columns, the Lally columns and the timber columns had unrestrained ends. Timber columns were tested with both cast-iron cap and pintle and steel plate cap bearings.

All steel columns were fabricated integrally with a steel head 3 ft. long, protected with concrete, which served to transmit the load from the ram. The other columns were attached to a head which served a similar purpose. The base of each column was embedded for 8 in. in fireproofing, leaving 12 ft. of length exposed to the fire.

A view of the testing furnace with auxiliary equipment and column in place is shown in Fig. 1, and details of the testing machine in Fig. 2.

Procedure In Fire Tests—The columns were subjected simultaneously to the working load and to a fire exposure increasing in accordance with a predetermined time-temperature relation until failure occurred or until they had withstood a test of 8 hr. In the latter event the load was immediately increased under full fire exposure until failure occurred. The working load was maintained constant on the column throughout the test by means of a calibrated hydraulic ram of 545,000 lb. capacity. The fire exposure was obtained by placing the columns in a gas-fired furnace with brick walls and concrete block roof, with a combustion chamber 7 ft. square by 12 fit. high. The furnace temperature was regulated closely in accordance with a time-temperature control curve which has been adopted by national technical organizations and testing laboratories. This curve calls for the following temperatures: 5 min., 1,000° F.; 10 min., 1,300° F.; 30 min., 1,550° F.; 1 hr., 1,700° F.; 2 hr., 1,850° F.; 4 hr., 2,000° F.; 8 hr., 2,300° F.

Measurements of the furnace and column temperatures, as well as the vertical and lateral deformation of the columns were taken throughout the tests. All temperatures were measured by electric thermo-couples. For the furnace, four couples were placed at different parts of the combustion chamber and for the columns, from seven to fourteen were placed at three or four levels, both on the column itself and in the covering. The vertical and lateral deformations were measured by means of two horizontal wires, 37 in. apart, attached to each side of the columns and protected with water jacketed sleeves within the furnace and extending to fixed points outside. The vertical movement of these wires was very accurately measured at an intermediate point by means of micrometers. The center deflection of the columns was measured by taking reading with reference to the reflection of point on the wires in polished metal scale. The effects of the fire on the test column were served through mica-glazed holes in the furnace walls.

Procedure In Water Tests—The fire-and-water tests began with a pre-determined fire exposure based on the ultimate fire resistance of similar columns in the fire series, but not exceeding 1 hr., after which a 1¼-in. hose stream at from 30 to 50 lb. nozzle pressure was immediately applied to the highly heated column from a distance of 20 ft. for a period of 1 to 5 min., depending on the type of column covering. The water was applied in succession over the full height of three of its sides.

Summary of Results—The schedule of fire tests giving details of columns and coverings together with the time to failure and the fire resistance period assigned to each column tested is tabulated in Fig. 3. In Fig. 4 are shown typical cross-sections of columns with different protective coverings. The useful fire resistance periods for columns and coverings arranged by groups are given in Table 2. Views of typical columns in the fire series taken after test are shown in Fig. 5. It is pointed out that a considerable portion of the impairment of the covering, particularly in the region of failure, was in many cases caused by the large deflection of the column which usually occurred at failure.

The time of failure extends from the beginning of the test to the time when the column is unable to sustain the applied working load. The useful fire resistance period has been derived for columns within any group of similar tests by taking *two-thirds the average time to failure* within that group, provided no single test in the group is of shorter duration than the designated period. The one-third reduction is made to allow for all variations due to materials, workmanship and test conditions, and because of the fact that the number of tests in any group was not sufficient to develop the full possibility of difference in results. In assigning these periods consideration was given the results of the fire and water tests, and for the protected columns it was also required that after a 2-min. application of water the column section should not have become exposed in any place and that a sufficient amount of covering should have remained in place to prevent early failure of the column on subsequent fire exposure.

Those columns given the 8-hr. rating withstood the 8-hr. fire test satisfactorily and immediately sustained increased loading of two to three times the working load before failure occurred.

Unprotected Steel Columns—The tests showed conclusively that unprotected structural steel columns of

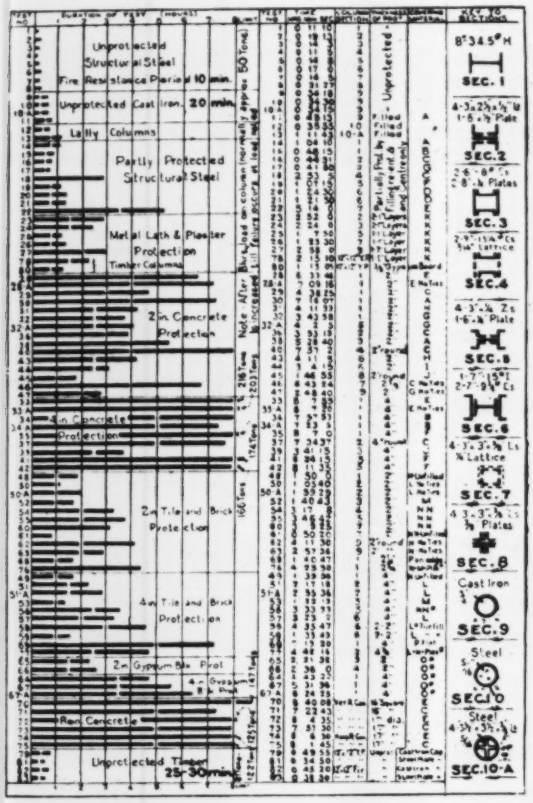


FIG. 3. RESULTS OF FIRE TESTS SUMMARIZED BY DIAGRAM

Key to Covering Materials

a—1 : 2 : 4 limestone gravel concrete.
b—1 : 2 : 4 N. E. granite concrete.
c—1 : 2 : 4 N. Y. trap concrete.
d—1 : 3 : 5 N. Y. trap concrete.
e—1 : 2 : 4 Chicago limestone concrete.
f—1 : 3 : 5 Chicago limestone concrete.
g—1 : 2 : 5 hard-coal cinder concrete.
h—1 : 2 : 4 Cleveland sandstone concrete.
i—1 : 3 : 5 Cleveland sandstone concrete.
j—1 : 2 : 4 siliceous gravel concrete.
k—Metal lath and cement plaster.
l—Surface clay tile.
m—Shale tile.
n—Medium-hard semi-fire clay tile.
nn—Hard semi-fire clay.
o—Solid gypsum blocks.
p—Common clay brick.

NOTE—Total length of lines in chart shows time to failure in each test; break in line indicates useful fire resistance.

All partly protected columns tied with vertical and horizontal wire ties. Concrete protections tied with No. 5 B & S gage steel wire wound spirally on 8-in. pitch unless otherwise noted. In tile-protected columns concrete filling placed between tile and column unless otherwise noted. Tests marked with asterisk following letter denoting covering indicate that tile or gypsum block was tied with metal ties in horizontal joints; otherwise tied with wire around outside each course.

any kind have little value from a fire resistance standpoint and they should not be used in building construction where they could be subjected to a fire of any appreciable degree of intensity or duration, particularly in buildings more than one story high. In all such cases some form of protective covering should be provided. This may be done by filling the reëntrant portions or interior with concrete or by fully covering the steel with concrete, cement plaster on metal lath, hollow clay tile, brick, or solid gypsum block, the kind of material and the thickness of covering depending upon the amount of protection desired.

Unprotected steel columns proved unable to support their calculated working loads after temperatures in the metal of from 900° to 1,100° F. have been reached, the variation being due to the differences in the applied unit loads with different radius of gyration. The total expansion of the steel columns varied from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in., the lower values being due to local heating caused by failure of a portion of the covering. The shape of the steel section appeared unimportant except as it affected the size of the column protection. Slenderness ratio, within the limits of 40 to 80, seems to have had little influence on the fire resistance; the center deflections for columns with these ratios were less than $\frac{1}{4}$ in. up to the time when the column had reached its maximum expansion, though for higher ratios center deflections of nearly 1 in. were noted at this stage. As this deflection might necessitate replacement of a column after a severe fire when it would not otherwise be impaired, it is thought advisable to keep the slenderness ratio below 80, especially with the poorer types of protection.

Protected Steel—The value of a column covering depends both on the action of its heat insulating and absorbing properties in retarding the temperature rise in the columns, and on its ability to carry a portion of the column load. The initial load-carrying capacity of the covering varies with the rigidity of the covering and its sectional area as compared with the steel. As heating proceeds the higher rate of expansion of the metal causes the load originally carried by the covering to be

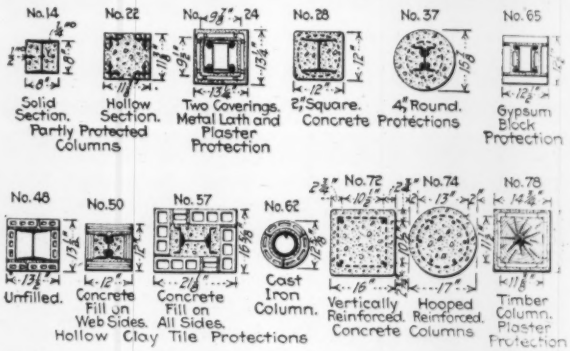


FIG. 4. TYPICAL SECTIONS OF COLUMNS AND COVERINGS

transferred to the steel until, at the point of maximum expansion, the metal has become heated to such an extent that compressive yielding takes place, causing a constantly increasing portion of the load to be transferred to the covering, the amount depending on the load-carrying capacity of the latter after the fire exposure. This load-carrying capacity of the covering considerably increases the time to failure of the column, in some cases the increase being over 100 per cent. The lighter unit loads to which the steel is subjected during this period make it possible for the metal to reach higher temperatures before failure; average effective temperatures of 1,400 to 1,500° F. were observed in some cases.

Concrete is considered the best covering material, not only because it gave the highest degree of fire resistance of any of the coverings tested but also for reasons based on other points of view. The necessary materials are usually readily obtained, the placing of the covering is subject to lesser variations due to workmanship than in the cases of materials not applied integrally, the cost is in most cases appreciably less than that of any other material giving the same degree of protection, and concrete covering can usually be readily repaired after moderate fire exposure whereas with most other materials partial or complete replacement is necessary.

USEFUL FIRE RESISTANCE PERIODS OF BUILDING COLUMNS AND COVERINGS

Type of Protection	Type of Column Section and Details of Protection	Minimum Area of Solid Material Sq. In.	Useful Fire Resistance Period
Structural Steel Columns			
Unprotected	**Any type of section** Minimum metal thickness 0.20 in.	8	10 min
Partly protected by filling reentrant spaces with concrete	**Solid steel section**		
Limestone, trap rock, granite, sandstone or hard coal cinder aggregate	Mixture 1:6 or 1:8. Concrete tied with vertical and horizontal ties	35	½ hr.
Limestone or trap rock aggregate	Do.	60	¾ hr.
Partly protected by filling reentrant spaces and interior with concrete	**Hollow latticed steel section**		
Trap rock aggregate	Mixture 1:6. Concrete extends to outside of rivets, covering lattice and main members	120	2 hr.
Limestone aggregate	Do.	120	3½ hr.
Metal lath and plaster	**Any type of section**		
One covering (1 in. thick)	Mixture 1:1/10:2½ Portland cement, hydrated lime and sand	40	¾ hr.
Two coverings (each ¾ in. thick)	Do.	80	1½ hr.
2-in. concrete	**Any type of section**		
Siliceous gravel aggregate	Mixture 1:6. Concrete tied with not less than equivalent of No. 5 (B. & S. gage) wire on 8-in. pitch	100	1 hr.
Trap rock, granite sandstone or hard coal cinder aggregate	Do.	100	2½ hr.
Limestone aggregate	Do.	100	4 hr.
3-in. concrete			
Trap rock, granite, sandstone or hard coal cinder aggregate	Do.	140	3½ hr.
Limestone aggregate	Do.	140	6 hr.
4-in. concrete			
Siliceous gravel aggregate	Do.	200	2½ hr.
Trap rock, granite, sandstone or hard coal cinder aggregate	Do.	200	5 hr.
Limestone aggregate	Do.	200	8 hr.
2-in., 3-in. and 4-in. hollow tile	**Solid steel section**		
*Medium hard semi-fire clay with no filling	Outside wire ties. Mortar joint between tile and column flanges	80	1 hr.
Surface clay or shale tile with concrete filling on web sides	Do. Filling serves as partial concrete protection	100	1 hr.
Extra heavy surface clay with filling on web sides	Do.	160	1½ hr.
Semi-fire or surface clay with filling on all sides	**Any type of section** Outside wire ties. Filling serves as full concrete protection at least ½-in. thick	160	2 hr.
Do.	Metal ties in horizontal joints, otherwise do	160	2½ hr.
2 layers 2-in. hollow tile	**Solid steel section**		
Surface clay with hollow tile filling	Metal ties in horizontal joints. Mortar joint between tile and column flanges and webs	240	3 hr.
Do.	Outside wire ties, otherwise do	240	1 hr.
2½-in. common brick	**Any type of section** Brick set on edge and end. Brick filling	140	1 hr.
3½-in. common brick	**Any type of section** Brick laid flat. Brick filling	240	5 hr.
2-in. solid gypsum block	**Any type of section** Gypsum block or poured gypsum filling; metal ties in horizontal joints; mortar joint between blocks and column flanges	130	1½ hr.
3-in. solid gypsum block	Do.	150	2½ hr.
4-in. solid gypsum block	Do.	240	3½ hr.
Round Cast-Iron Columns			
Unprotected Unfilled	Minimum wall thickness 0.60 in.	12	25 min.
Unprotected Interior filled with concrete	Do.	35	½ hr.
Metal lath (high ribbed) and plaster One covering; (1½ in. thick)	Mixture 1:1/10:2½ Portland cement, hydrated lime and sand; ½-in. air space	60	2 hr.
2-in. concrete Trap rock, granite or hard coal cinder aggregate	Mixture 1:6 or 1:7. Concrete tied with not less than equivalent of No. 5 (B. & S. gage) wire on 8-in. pitch	70	2 hr.
2-in. hollow tile Porous semi-fire clay	Outside wire ties. Mortar joint between tile and column	70	2 hr.
Unprotected	**Steel pipe filled with concrete** Concrete mixture 1:1½:3	45	25 min.
Unprotected	**Steel pipe filled with concrete and reinforced in fill with structural shapes.** Concrete mixture 1:1½:3	55	¾ hr.
Reinforced Concrete Columns			
2-in. integral concrete protection	Round or square vertically reinforced or hooped reinforced. Concrete mixture 1:6. Trap rock aggregate	220	5 hr.
2-in. integral concrete protection	Round or square vertically reinforced or hooped reinforced. Concrete mixture 1:6. Limestone aggregate	220	8 hr.
Timber Columns			
Unprotected	Unprotected steel plate cap bearing	120	25 min
Unprotected	Unprotected cast iron cap and pintle bearing	120	½ hr.
½-in. gypsum wall board	Cast iron or steel plate cap bearing, protected	140	¾ hr.
Metal lath and plaster One covering (½-in thick)	Cast iron or steel plate cap bearing, protected. Mixture 1:1/10:2½, Portland cement, hydrated lime and sand; ½-in. air space	160	1½ hr.

* Any other kinds of clay tile not recommended, as tests indicate periods of ½ hr. or less.

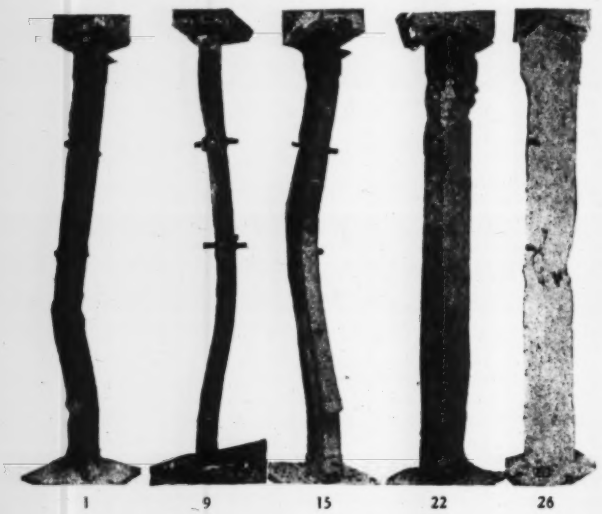
From a fire standpoint alone, however, other materials make equally satisfactory coverings provided their fire-resistance periods are sufficiently great to meet the necessary demands.

Concrete may be applied to steel columns either as a partial or full protection. The partial protection should completely fill the interior and reentrant portions of the main members. For columns of solid rolled or riveted sections this leaves the faces of the flanges exposed; for those of hollow latticed section the concrete is flush with the outside of rivet heads, completely covering the structural section and lattice bars. The full protection should cover all portions of the main structural members, including lattice bars and splice plates, by not less than the nominal thickness specified, although with round coverings the distance to the edge of the main column members may be reduced somewhat providing the resulting cross-sectional area is not less than that of a covering of the same nominal thickness. A 1-in. covering is sufficient protection for brackets and other details of small area.

For concrete protections the two variables which most greatly affect the fire resistance are the total cross-sectional area of the column and covering and the kind of concrete aggregate employed. It was found that all other details being similar the resistance of the column is fairly proportional to its cross-sectional area. For this reason minimum areas are specified in the table of

useful fire-resistance periods, and areas at least equal to these minimums should be used to obtain the rated periods.

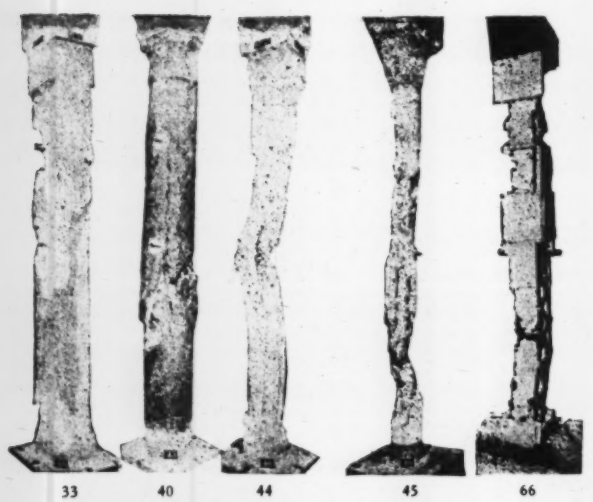
Character of Covering Concrete—The difference in protection afforded by the various kinds of concrete is very great. The different kinds of aggregate ordinarily used can be divided in this respect into three groups as follows:



1 9 15 22 26

UNPROTECTED COLUMNS
Rolled II (No. 1)
Cast Iron (No. 9)

PARTLY PROTECTED COLUMNS
Rolled H, column, granite, concrete covering. (No. 15.) Latticed column, limestone, concrete covering. (No. 22.) Steel column, metal, lath and plaster covering. (No. 26.) Note little damage to covering.



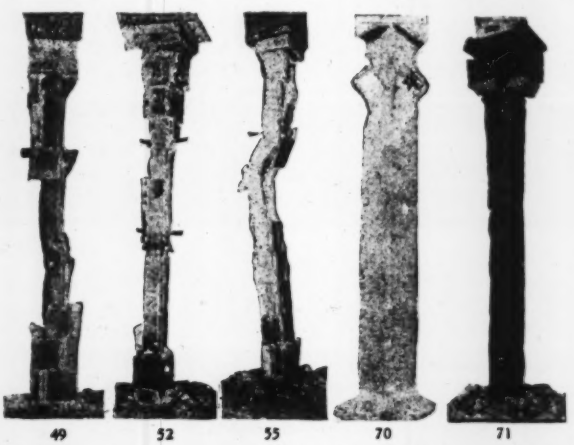
33 40 44 45 66

STEEL COLUMNS WITH FULL CONCRETE PROTECTIONS

4-in. limestone concrete. (No. 33.) No cracking or spalling before failure. 2-in. trap, concrete. (No. 40.) Note fusion. Sandstone concrete. (No. 44.) Note corner cracking. Siliceous gravel concrete. (No. 45.) Note excessive cracking and spalling. 4-in. gypsum block. (No. 66.) Note cracking and shrinkage.

1. Siliceous gravel or other siliceous materials especially those containing a high percentage of chert, which is a non-crystalline form of silica containing water in chemical combination. Concrete made with this aggregate was found to be subject to excessive cracking and spalling on fire exposure, which greatly reduced its fire resistance as compared with other kinds of concrete. It is not recommended for use as a covering material when other kinds of aggregate can be obtained, and should not in any case be used for partial protections. (Tests subsequently conducted at the Pittsburgh Laboratories of the Bureau of Standards indicate that the fire-resistive properties of coverings made of siliceous gravel concrete can be appreciably increased by placing a reinforcement of expanded metal lath in the concrete. This procedure may sometimes be necessary where it is impracticable to use other kinds of aggregates).

2. Trap rock, granite, sandstone or hard coal cinders. Concretes with these aggregates all offer approximately the same amount of fire resistance, their periods being intermediate between those of high siliceous and of limestone aggregate concretes. Trap rock is slightly preferable provided it is a true trap. Trap rock and cinder concrete developed no spalling in the test although there was a slight amount of cracking during the latter part of the tests. The granite and sandstone cracked and spalled to some extent principally at the corners, the standstone showing these effects to the greater degree. A slight amount of fusion of the trap and granite concretes took place after tests of more than 7 hr. duration, but this had no apparent influence on the results.



49 52 55 70 71

STEEL COLUMNS WITH GYPSUM AND HOLLOW TILE PROTECTIONS

4-in. medium-hard semi-fire clay tile, no filling. (No. 49.) Note thermocouple wires. 2-in. shale tile, concrete filling on web sides. (No. 52.) 2-in. hard semi-fire-clay tile, concrete filling on all sides. (No. 55.)

REINFORCED-CONCRETE COLUMN

Limestone concrete, 2-in. over steel. (No. 70.) Failure due to overloading after 8-hr. fire exposure, no spalling before.

TIMBER COLUMN, UNPROTECTED

Cast-iron cap and pintle bearing. (No. 79.) Note cap failure.

FIG. 5. CONDITION OF REPRESENTATIVE COLUMNS AFTER TEST—IMPAIRMENT OF COVERING DUE TO FIRE ESPECIALLY IN REGION OF FAILURE IS EXAGGERATED IN MOST CASES BY DEFLECTION OF COLUMN AT TIME OF FAILURE

[*To be continued in next week's issue*]

Error in Article on European Bridges

In the table accompanying Fig. 3 of the article "Railway Bridge Construction, etc.," *Engineering News-Record*, July 14, 1921, p. 58, the lateral vibrations for Engine No. 153 was given incorrectly as 11.5 mm. As the whole tenor of the article showed this figure is much too great. It should have been 1.5 mm.

Three Concrete Road Construction Methods Compared

Truck Breakdowns Excessive—High Labor Turnover—Central Plants Superior to Wheelbarrow Work

[*Side by side comparison of methods of concrete road construction is rarely possible. In the construction near Charles City, Iowa, described below, this opportunity existed. Co-ordinated by brief investigation by a member of this journal's editorial staff, statements of facts and conclusions furnished by E. B. Gordon, resident engineer and Thure W. Ingemanson, inspector, Iowa State Highway Commission, are herewith presented.*]

OPPORTUNITY to compare the wheelbarrow method, the central proportioning plant method and the central mixing plant method of concrete road construction was afforded last season in building 12 miles of road north and west from Charles City, Iowa. The sketch plan indicates some of the controlling conditions, which were substantially alike for all sections of the road. Two contracts, A and B, were awarded. Sections 4 and 6 of contract B were constructed by the wheelbarrow method, and sections 1, 2, 3 and 5 by truck haulage of dry batches from a central proportioning plant. All the sections of contract A were constructed by wet batch haulage from a central mixing plant.

Statement of Operations

An 18-ft. pavement, 7 and 8 in. thick, was constructed, using a 1:2:3½ mix on contract B and a 1:2½:1 mix on contract A. On contract B, sections 1, 2 and 3 were concreted in order, using trucks to haul the dry batches to the mixer. With sections 1-3 completed, a wheelbarrow outfit was started on section 4 and the truck outfit on section 5, both outfits working east. When section 4 was completed, the wheelbarrow outfit was moved to section 6 and worked north and west to meet the paving on section 5. On contract A, the sections were concreted in the order numbered, section 10 being carried over to 1921.

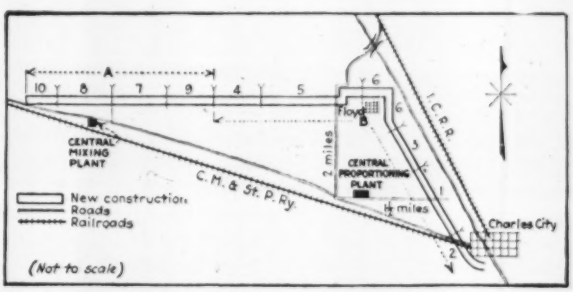
Central Proportioning—The central proportioning plant has the usual equipment of unloading derrick, overhead bins and cement warehouse. The derrick unloaded into the bins or into stockpiles. Rail deliveries were ample, no delay, practically, resulting from lack of stock at the proportioning plant.

Proportioned batches were hauled by one-ton trucks, with special dump bodies. Work was started with 15 trucks; later 20 trucks were used, and when the haul increased for section 5 west of Floyd, some two-batch, 2-ton trucks were added. These supplementary trucks were not added until the long 3¾-mile average haul was begun, and then the trucks were employed 70 per cent of the time hauling aggregate from the Floyd station to the wheelbarrow sections. All of the short haul work was done with the one-ton trucks.

For dry batch haulage and concreting, the organization consisted of: 5 men, with two teams, unloading aggregates; 2 men loading trucks; 5 men handling cement; 25 trucks; 3 men on the mixer; 6 men placing concrete for hand finishing; 1 man finishing; 1 water boy; 2 to 3 fine graders; 2 formsetters; 5 mechanics; 1 pumpman; 1 sprinkler man, and 2 men covering the slab. With this gang, including two foremen, of 64 men, the average output was 400 ft. in 12 hours.

Wheelbarrow Work—The organization for wheelbarrow construction consisted of: 5 men with two teams, unloading aggregates; 3 men handling cement; 3 trucks; 4 men, with two teams and two trucks, hauling cement; 2 men on the mixer; 16 wheelbarrow men; 6 men placing concrete for hand finishing; 1 man finishing; 1 water boy; 2 fine graders; 2 form-setters; 1 pumpman; 1 sprinkler man; 2 men covering and 1 foreman. The average output was 275 ft. per 11-hour day for this crew of 50 men.

Stockpiling for the wheelbarrow work began fully a month before concreting and continued until the last moment of the operations. In times of stress, the trucks hauling this aggregate, which were normally loaded by hand at the Floyd station, were manned by a night crew using the loading equipment at the central proportioning plant. The cement was sometimes unloaded directly from the cars into the trucks and sometimes it was handled through the central proportioning plant warehouse before being hauled to storage



SKETCH MAP OF CONCRETE ROAD

places along the road from which places it was hauled by team to the mixer.

Central Mixing—The central mixing plant consisted of the usual unloading derrick, overhead bins and mixer and cement warehouse. The operating organization was: 5 men unloading sand and gravel; 7 men handling cement; 11 trucks; 2 men, with one team and one tractor, hauling cement; 3 men on the mixer; 3 men placing concrete for machine finishing; 1 finisher; 1 water boy; 4 fine graders also covering the slab; 2 form-setters; 4 mechanics; 1 pumpman; 1 sprinkler-man; 5 men feeding conveyor and 2 foremen. The output, with 52 men, averaged 250 ft. per 10-hour day.

Shortage of aggregates was a constant trouble in the central mixing plant operation. Since it was realized at the beginning that the gravel supply would be inadequate the proportions of the concrete were changed to 1:2½:1, which approximated more nearly the available material. This change, however, did not make the supply adequate for continuous operation. It also contributed a delay in increased time required to discharge the mixer, because of the high proportion of sand—the time required was about 30 seconds longer than for a 1:2:3½ mixture.

Study of the three construction methods indicates the important considerations to have been: (1) Truck operation and mortality, (2) labor turnover, and (3) relative advantages of methods.

Truck Mortality—The ordinarily bad haulage conditions of unimproved country roads prevailed. Under these conditions the truck mortality was great. In dry

batch haulage with one-ton trucks, not more than 80 per cent of the fleet was ever in operation and at the end of the season, 80 per cent of the trucks were reduced practically to junk.

Observation indicated that the whole blame cannot be placed on the truck. For example, one truck on dry batch haulage was practically as good as new at the end of the season's work and it was in service practically 100 per cent of the working time. The explanation is that this truck was excellently operated and maintained. The driver was a young man from the contractor's home town, who was paid more than the other drivers and who not only gave his truck excellent care but took pride in its appearance. Had the remaining trucks been equally well manned it is the opinion that they would have endured the work equally well.

Despite, then, a truck mortality of 75 per cent in dry batch hauling, it is believed that one-ton trucks, with the reasonable care to which any car is entitled and especially on 1½- to 2½-mile hauls, are efficient equipment. On longer hauls of 2 to 4 miles the two-ton truck is no doubt cheaper; although it is slightly slower than the one-ton truck, this objection is overbalanced by the larger load and the greater durability of the heavier construction. Truck mortality, in any case, is largely a question of efficiency of drivers as indicated in the succeeding remarks on labor turnover.

Use of Turntables

One factor which is not often considered in truck mortality is the practice of using or not using a turntable. Protection of the subgrade by using a turntable was only one of several benefits obtained. Saving in wear and tear on motors was an important gain. It was not uncommon, when the turntable was not used, to see drivers run their engines virtually red hot in struggling to make a turn on a soft or sandy subgrade. The engine depreciation due to many occurrences of this sort soon exceeded the cost of a turntable.

Besides the direct savings by using a turntable there was an evident gain in regularity of truck operations. Resident engineer E. B. Gordon states:

> Without a turntable I have seen as many as seven trucks trying to back and turn at the same time, often getting in each other's way, killing their engines, heating up their motors to the limit and generally demoralizing the drivers. With a turntable, the trucks drive up in an orderly procession, are turned around, back in and dump their loads and start back to the central plant without confusion.

It was a tiresome task for a driver to turn a heavy load on an 18-ft. subgrade, particularly if the footing was poor due to soft soil or sand. The difficulty and confusion reduced the morale of the drivers and the whole concreting crew. Two-ton trucks with pneumatic tires, because of their wider tread, did no more damage to subgrade than did the one-ton trucks. With solid tires the two-ton trucks were destructive.

Labor Turnover—Labor turnover furnished an interesting study. It was greatest on the wheelbarrow operations. In two months three entirely new crews were employed. A crew of Mexicans lasted about three weeks and was followed by a crew of negroes which lasted about two weeks. Finally a crew of white men was obtained, but had it not been for the fortunate closing of a local factory, it is doubtful if men could have been secured or the wheelbarrow sections completed in the allotted time. On the central proportioning plant the greatest turnover was of truck drivers. The central mixing plant drew its labor from the locality and had the smallest turnover as well as more efficient help.

Quality of Labor

Observation of labor indicates the need of more careful attention to quality where machine operations are largely involved. The heavy turnover of truck drivers has been mentioned. As there was always a waiting list of local town boys wanting to drive trucks this rapid turnover did not on the face of things appear to be a serious factor. The waiting list, however, was made up of "kids looking for a soft job," and as stated by Mr. Gordon:

> Floaters do not make good caretakers of cars and on a truck outfit this is one of the most important factors to be considered, both from the standpoint of depreciation of machinery and as it affects the delivery of material. The trucks are the life of the job and they require constant conscientious care by their driver which cannot be expected from boys looking for an easy temporary job. Besides, drivers of this class waste time on the road. Labor is the most important factor in construction performed mostly by machinery. Machinery does the work in road construction with truck haulage from central plants, and requires competent help to keep it working efficiently. Many contractors overlook this fact and believe they are saving money by hiring boy operators at low wages, instead of making their machinery more efficient by hiring older skilled men at wages which will keep them in the work and interested in their machines.
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> On the dry batch haulage operations truck drivers were getting 40c. and 50c. an hour, or less than the Mexican wheelbarrow men, who were paid 60c. an hour. It is, therefore, small wonder that truck mortality was high. This high mortality resulted in delay at the mixer on the long haul which made at least 15 per cent of the placing outfit's time a total loss to the contractor.
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> On the wheelbarrow work, the high turnover was due not to low wages, but to unrest and independence. Labor was scarce and correspondingly careless about holding a job.

Comparison of Methods—Under the condition observed the yardages per man per hour were: Wheelbarrow, 1.11 sq.yd.; central proportioning, 1.10 sq.yd.; central mixing, 1.31 sq.yd. In comparing the organizations given, the difference between central proportioning and central mixing in number of men required is misleading, because the job using dry batch haulage had an adequate amount of material at all times and was able to work a large fleet of trucks, while the job using wet batch haulage was handicapped by a shortage of material throughout the entire season and could, therefore, not employ the maximum fleet of trucks inasmuch as the daily output was reduced about 50 per cent by lack of materials. Comparing the average daily output of the two outfits, Mr. Gordon states:

> I found that labor proved to be in the same proportion, making labor costs equal and leaving only a matter of personal opinion, between the two methods, as to which is the best to use under varying conditions. Personally, I can see no advantage, one over the other, in the matter of cost on a short-haul job, and on a long haul I think either method gets too expensive and the work should be classed as an industrial railroad job. With an average haul of 3¾ miles on Division B west of Floyd, the labor cost doubled over the labor cost where the average haul ran from 1¼ to 2¼ miles as it did from Floyd to Charles City.

Assuming central proportioning and central mixing to be equal in cost of operation, both exhibited the following advantages over wheelbarrow work:

1. Reduced demurrage bills on account of being in a position to unload cars on to stockpile immediately

after they have been spotted on side track. On wheelbarrow outfits, it is usually desirable to shovel directly from the car, with a result that, inclement weather, muddy roads, etc., tie up operations. Then, if unloaded onto the ground, the material has to be handled twice by expensive methods before it is even dumped on the subgrade since an outfit of this kind is seldom equipped with a crane.

2. Reduction in waste of fine and coarse aggregate from approximately 10 per cent on wheelbarrow work to about 1½ per cent on truck work. The latter percentage was determined by actual observations on five different concrete jobs last year, all within a radius of 30 miles of Mason City.

3. A reduction in the number of ordinary laborers required continuously on a wheelbarrow job, a problem worthy of consideration of any country road work requiring any great number of men.

4. A reduction in the cost of handling all materials. For example, on a wheelbarrow job, all material is handled; first, from the car into trucks or wagons and hauled to the paving site to be dumped on the subgrade; second, it has to be handled again by shoveling into wheelbarrow, and in case of bad weather, requires either a third handling at the siding, or demurrage bills, either of which are more or less expensive. These operations are ordinarily performed by hand and are expensive. On the other hand, using the truck outfit, material is handled twice also, but with machinery which greatly reduces the cost.

5. It is very difficult, in fact nearly impossible, to secure a satisfactory subgrade where the aggregate is dumped on the subgrade. Even though the subgrade has been prepared in first-class shape the trucks hauling material to the job will cut up the grade more or less, and generally more, and after the material has been distributed out ahead of the mixer, it is practically impossible to work a roller in ahead of the mixer to put the grade in the shape it should be. Although trucks cut up the subgrade by the Central Plant method a roller can still be worked to good advantage and a fairly good sub-grade obtained even though it is not as perfect of course as can be obtained by the industrial railroad method in conjunction with a subgrade machine.

Slate Dust for Asphalt Mixtures

The manufacture of filler for road asphalt mixtures is a promising field for slate waste utilization, according to the U. S. Bureau of Mines. At present from 80 to 95 per cent of the gross production of all slate quarries in the United States is discarded as waste. In the preparation of asphaltic mixtures for surface roads, in addition to the sand and stone aggregates, finely pulverized limestone or portland cement is ordinarily used as a filler. The City of New York alone requires about 50,000 tons of this filler material annually. An attempt has been made by the Bureau to determine the adaptability of slate flour for such use. The results of its experimental work, while not yet conclusive, indicate that the use of slate flour as a filler in asphalt road surface mixtures would result in improved highways and that a wide use of such filler would afford a profitable outlet for waste slate, with consequent advantage to the slate producing industry. The cost of slate flour is little more than half that of portland cement.

Draining Concrete Railroad Tunnels

SINCE concrete lining has been placed extensively in railroad tunnels of the west the question of how adequately to drain them has been receiving special attention. The old practice of leaving 2-in. pipe weep holes in the concrete has proved unsatisfactory. These small holes choke easily, and unless careful inspection is made regularly and a special tool is used—two requirements which it is desirable to avoid as far as possible—they cannot be depended upon to function. Cases are on record in which wall footing and invert 2 ft. in thickness were broken and distorted by hydrostatic pressure behind inadequately drained concrete lining.

A modern standard for tunnel weep holes, which has so far proved very satisfactory, has been adopted on the Pacific division of the Southern Pacific Railroad. These holes 6 x 8 in. in size are being made standard in all concrete tunnel lining. They are formed by boxes made up of 1-in. lumber, placed in the forms before pouring, and are spaced 10 ft. apart. The wood is intended only for service while the concrete is setting, and may be removed any time thereafter or left in place to decay. The holes are located just above the sill or on a level not lower than the top of the tie so that a tamping bar can can be readily thrust into the hole to clear out obstructions. For all but very short tunnels weep holes are always provided in concrete lining even though no water has appeared up to the time the lining is placed. The cost is so little and the insurance against dangerous pressure is great.

Effect of Tunnel Grades on Drainage

In long tunnels there are several other considerations involved in a satisfactory drainage system for getting water to the portals. The first of these is sufficient grade. Maintenance engineers oppose the construction of tunnels on less than 0.3 per cent grades, as anything less is likely to mean difficulty in maintaining drainage. The use of drain tile buried in the ballast either on center line or at the sides leaves a roadbed that can be finished off level, but there is danger that the tile will clog with mud and involve expensive maintenance if not still more serious objections.

The use of covered plank troughs along each wall with frequent openings in the sides has been fairly satisfactory. The cover can be removed and the trough cleared out with a square-nosed shovel. They are unsatisfactory insofar as they are sure to collapse in time due to the decay of the wood, an event greatly hastened by the conditions ordinarily obtaining in a tunnel drain. A better design comprises a concrete curb at least 10 in. from the wall, provided with openings through which water can escape from the ballast. If such a curb is provided with a shoulder, and a projection or ledge is cast at the same level along the wall, a cover plank can be placed over the drain to protect it from débris and to serve as a walk. Such a plank is permissible as a part of permanent construction because it is not in contact with water or moist earth and can be easily removed by hand for inspecting or cleaning the trough.

Whatever detail of arrangement is adopted, there are two requirements that will always be met in good practice, (1) a design such that inspection and cleaning can be made easily with tools which track men ordinarily carry and (2) the elimination of wood or other material subject to rapid decay except in very favorable conditions or on temporary construction.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Copyright Dates in Book Catalogs Urged

Sir—Catalogs of most of the book publishing concerns do not give the date of the copyright of their books. It is a great inconvenience to send off for a book which should be of recent date to find that it is ten or fifteen years behind the times. It simply means the return of the book and dissatisfaction. I suggest, as an improvement over the present practice, that publishers give copyright dates in their catalogs.

University of Idaho, Moscow, Idaho. T. C. MEAD, Associate Professor of Agricultural Engineering.

Goldman's "Financial Engineering"

Sir—My attention has only recently been called to the review of my book, "Financial Engineering," in your issue of Jan. 20, p. 127. The review shows careful study and is very good.

On p. 20 of "Financial Engineering" I specifically caution the reader on the matter of wear in these words: "The reader is cautioned not to confuse depreciation with wear as is often done in practice." This is followed by detailed discussion on this point. In spite of this, so strong is custom, that your reviewer falls into that very error, maintaining that wear should be charged as depreciation; that is as a fixed charge, which would imply that wear continues whether the equipment "is in use or idle." This is absurd. His excuse for not charging major repair items as an operating cost is that "this would distort the annual expenses of certain years . . ." This is unnecessary since a sinking fund can be provided for wear just as well as for depreciation or any other long-interval expense, if the operating life and the amount of use are known at least approximately. True, I employ a life table in which wear is a factor. No other data are available. The distinction between the operating and natural life has never before been made. But that does not alter the fact that wear does not occur when the unit is idle, and any analysis based on the opposite assumption will inevitably lead to error.

So also your reviewer takes exception to my considering depreciation as a trust fund. I do not know and do not care what economists think about this. "Eminent jurists" do not hold otherwise. They hold that the duty of a public utility is to render fully and adequately, the service that they undertake or contract for. And this can only be done if worn-out and depreciated equipment is continually replaced. If this fund is pocketed, how is depreciated equipment to be replaced? It would be only another way, and a very poor way, of going out of business. The position that such equipment could be bought and charged to capital invested would be utterly untenable. And what holds true for public utilities, holds equally for private business. The truth can only be arrived at by a correct analysis.

I do not understand your reviewer when he says that "the early part of the book is disconcerting because of a few radical dicta," as for example when "he avers that 'even the most elementary study shows there is no such law'" as the so-called law of supply and demand. Why "disconcerting"? Why "radical dicta"? Does he imply that my statement is incorrect? If so I shall gladly meet his challenge. Or is it "disconcerting" merely because it is different from what we have incautiously been swallowing? O. B. GOLDMAN.

Portland, Ore., May 11.

[The reviewer's reply to the foregoing letter follows. —EDITOR.]

Sir—Among the specific points that Professor Goldman brings up, one real question is whether or not his dogma on depreciation are preferable to the present accepted composite ideas which are the growth of many years of engineering, economic and legal thought. There have been so many attempts to hitch radically different definitions to the innocent word "depreciation" that confusion has been confounded. To add another definition and to build a book or a school of thought about it now, would be a misdemeanor properly punishable by sentence of forced listening to the whole ensuing discussions.

Professor Goldman makes depreciation result only from obsolescence, inadequacy and idleness, and he imagines a "natural life" terminated by these effects only —as contrasted with an "operating life" which may be ended by one or all of obsolescence, inadequacy, supercession, lack of requirement, or irreparable wear and tear. Such a distinction appeals to me as too artificial and academic, for little equipment is allowed to lie around in desuetude. It gives inadequate results to base the annual depreciation allowance, which is practical, specific, cold, matter-of-fact money, on such an unnatural idle life when the money needed depends on a life determined by final inability to make good by repairs the effects of activity. All this Professor Goldman really admits when he says that he uses life tables based on wear and tear, for "no other data are available"—and never will be from the very nature of the actions involved.

The author in his letter insists that the annual depreciation allowances are to be gathered into a trust fund created to buy new equipment with. In the first place with growths of business and development of the arts, the trust will be insufficient and an investment will still be needed. The next inevitable step from the trust idea is to make the annual depreciation allowance depend on not what the items of property actually cost but on what will be the cost of the future substitute.

I believe that it is clearer, more logical, more economical as to production cost, conducive to better management and in harmony with the principles of the United States Supreme Court decisions and the several state accounting codes, to regard the depreciation allowance as the concurrent payment of a loss of invested capital. Once the repayment is made the investors can do with it as they please. So long as they are in a public utility business they must maintain service and they will be ready to replace old antiquated apparatus with the latest designs if they have had their invest

ment returned to them. They do not need it tied up in a low-interest bearing fund when it could be employed in better paying extensions.

Such debatable assertions are the "disconcerting dicta" of Professor Goldman's book and of his letter. They are disconcerting because here and there theory is developed that must needs be discounted, because the inexperienced reader knows not how far such matters may permeate the rest of the book, because they betoken a Quixotic attitude that will not even recognize definite economic accomplishments.

It must be remembered, finally, that all these things here discussed are of no very great importance in view of the general excellence and utility of the book itself.

Montclair, N. J., July 2. HARRY BARKER.

Monumental Work on Municipal Refuse

COLLECTION AND DISPOSAL OF MUNICIPAL REFUSE—By Rudolph Hering, D.Sc., New York City; Past President of American Public Health Association and of Engineers Club of Philadelphia; Past Vice-President Am. Soc. C. E.; M.A.S.M.E., etc., and Samuel A. Greeley, Chicago, Ill., M. of American Public Health Association, M. Am. Soc. C. E., Western Society of Civil Engineers, M.A.A.E., etc. New York and London: McGraw-Hill Book Co., Inc. Paper; 6 x 9 in.; pp. 653; illustrated. $7.

Monumental is a fitting word to characterize this treatise on municipal refuse. Aside from the merits of the book as a contribution to engineering literature, the volume is notable because it fittingly marks and crowns Mr. Hering's long years of investigation and practice in the important field of municipal refuse disposal. Mr. Hering was not only an American pioneer in this field but for many years he stood almost alone, particularly in presenting first-hand information on current British and European methods of garbage disposal. By putting the ripe fruits of his years of study into his book he deserves both commendation from engineers and emulation on the part of those rich in experience in other fields. Having said this much of the senior author it is only fitting to add that Mr. Greeley is one of the few younger engineers who have specialized in garbage disposal; that he made a tour of investigation with Mr. Hering in Europe some years ago; that subsequently he was engaged on the construction of the large incinerator at Milwaukee, and still later was in charge of the operation of the incinerator as well as of the collection and disposal of municipal refuse in that city. This combination of effort has produced a book rich in observation and experience in one of the most important fields of municipal sanitation. Coming from such authors at a time when municipal refuse collection and disposal is in a very unsettled transition stage and when the earlier books on the subject are by no means up-to-date "The Collection and Disposal of Municipal Refuse" is most welcome.

After a general survey of the field—which, like other parts of the work, includes Europe as well as the United States and Canada—there appear, in logical order, chapters on house treatment, collection, supplemental transportation, cost estimating for the latter, and a number of chapters on the various means of disposal. The chapters on disposal include depositing refuse in water and on land, feeding to hogs, sorting rubbish, incineration, and reduction. At this point the authors present chapters on estimating costs and on selecting the method of disposal. There follow chapters on stable rubbish, street refuse, night soil and dead animals. The final chapter is a general review of "Procedure in Small Towns and Villages." It will be seen that all municipal wastes except sewage are discussed, beginning with the point of origin (house treatment) and continuing with collection, supplemental transportation and final disposal. A good balance seems to be maintained, but perhaps some readers would expect more than is given on sweeping streets.

Notable features of the book are its abundance of statistical data, its chapter summaries and conclusions, its outlines for drawing specifications and last to be mentioned but not least in importance, the judicial attitude of the authors in presenting the claims of the various methods available for accomplishing the same end. As to the statistical data, the authors seem to have presented too much rather than too little, although apparently they have done much sifting. The impression that there is more tabular matter than will prove to be useful is perhaps heightened by the fact that a considerable part of it is rather old. This is due in part to the long time that the book has been under way. It might be urged that war and post-war conditions make many of the older figures equally if not more valuable than later figures would be. In so comprehensive a book as this one it is almost impossible to give thoroughly up-to-date figures. It is unlikely that anyone will be misled by the figures for the earlier years. The question rather is, are all the old figures of sufficient value to justify the extra bulk and cost that they cause? The tables should not be dismissed without commendation for their excellent form—praise that should also be extended to what may be termed the entire range of editorial work on the book, credit for which and for the index the authors heartily give to T. J. McMinn.

Finally, the book deserves a place with the best that are available on other brances of municipal engineering and sanitation. It will do much to place refuse collection and disposal on a sound engineering basis.

Irrigation Terminology

GLOSSARY OF TERMS IN USE ON PUNJAB CANALS. Prepared by H. W. Nicholson, B. Sc., Executive Engineer, Punjab Irrigation Branch. Simla, India: Government Press. Paper; 8 x 13 in., pp. 15; 2 folding plates.

In an introduction to this glossary T. R. J. Ward, inspector-general of irrigation in India (Delhi), writes forcibly regarding the importance of preciseness of definition in any work of a scientific character, and expresses the hope that irrigation engineers will unite for a common terminology on (1) individual canals, (2) within each province, and (3) throughout India.

Considered as an exhibit of "terms in use" in one district, and as making for uniformity within that district, Mr. Nicholson's "Glossary" is commendable. But even for use within a single district it would seem to be advantageous to be less arbitrary in some of the terms, while as a move towards a common terminology for India and Burma a more rational choice of terms seems necessary. Some elaboration of this criticism may not be unwelcome as a possible contribution toward a world-wide engineering terminology. Our remarks will be confined to the terms "average supply" and "mean supply," wherein two synonymous words, as both the context and common usage show, are employed arbitrarily to designate two different things. "Average supply," according to Mr. Nicholson, "is the sum of the daily discharges of the channel divided by the number of days the canal is open at its head," while

"mean supply" has exactly the same base "divided by the number of days in the crop." In other words, according to the "glossary" itself, "average supply" is "a measure of the rate of flow" and "mean supply" is "a measure of the water used." Why, then, not be specific and avoid confusion by using the terms "average supply" and "average use"?

Metallic Engineering Material

REVIEWED BY E. E. THUM

Associate Editor, *Chemical and Metallurgical Engineering*, New York City

THE CASE-HARDENING OF STEEL: An Illustrated Exposition of the Changes in Structure and Properties Induced in Steels by Cementation and Allied Processes—By Harry Brearley. Second Edition. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. 207; illustrated. $6.

FESTIGKEITSEIGENSCHAFTEN UND GEFUGEBILDER DER KONSTRUKTIONSMATERIALIEN—Von Dr.-Ing. C. Bach und R. Baumann, Professoren an der Technischen Hochschule Stuttgart. Zweite, Stark Vermehrte Auflage. Berlin, Germany: Verlag von Julius Springer. Cloth; 8x10 in.; pp. 191; illustrated.

Mr. Brearley, who is Works Manager of Brown-Bailey's, Ltd., an important steel company of Sheffield, England, writes a very informing book about the principles and practices of case-hardening. That operation, as is doubtless well known, consists of taking steel pieces which are low in carbon, soft and tough, and carbonizing the surface to a depth of perhaps $\frac{1}{8}$ in., whereby this "case" may be made glass hard. Pieces such as axles or armor plate which must be hard to resist wear or penetration and tough to resist impact are treated in this manner. Other parts, like ball races, which must be machined all over, can be cut from soft stock and later converted to a hard object incapable of being machined.

Case-hardening, as an art, rests on hoary tradition. Steel made in ancient times, and even today the steel produced by half-civilized tribes, comes in a rather haphazard way direct from the iron ore. The old smith desired to convert his ore into tough iron, and only when an excess of carbon entered his hot, spongy metal did it become steel—sometimes what we now know as pig iron was made inadvertently.

The first "indirect" process of making steel was invented about 1600. It made steel deliberately, and not by chance. It consisted of heating iron in close contact with charcoal, whereby the iron bar became a steel bar. This process is still commonly used by Sheffield iron masters for their finest cutlery, and is the direct ancestor of case-hardening practices.

Thus it is that the art described by Mr. Brearley is very largely controlled by rule of thumb; it is the fertile field for quacks and patent medicine vendors, and the hardeners themselves are men who are doing what their fathers told them was the right way to do—it was right because his father in turn told him it had always been done so. To reach these men and discuss their problems in a way which would be intelligible requires a clear style and an orderly development of the subject. But to get far along on this course it is necessary to introduce advanced metallurgy, for it has been only recently that the most searching investigations have shed light on the points in question.

Consequently the book in itself comprises an excellent introduction to the principles of physical metallurgy as applied to iron and steel, and, quite apart from its value as a text on case-hardening, could well be read by any engineer desirous of knowing something of the tremendous advances in machine design made possible by the discriminating use of heat-treated and alloy steels.

The rather unique German book noted above is an illustrated encyclopædia covering the strength of the metallic materials of construction. It presents graphs showing the relations between deformation and loading for a certain steel, for instance. Illustrations are printed alongside showing the typical test bar, the surface of fracture, and the normal microstructure. Many pictures are given of faulty structures and the nature of the breaks, both as seen by the eye and under the microscope. Carbon steels, plain and annealed, special alloy steels, cast iron and steel, malleable iron, brass, bronze, and the principal nonferrous metals are covered in this manner in 950 illustrations. Apparently most of the material is original with the authors. Typographically the book is excellent, the micrographs being particularly well printed. It would be a good reference book for any control or testing laboratory working with metals.

For Students of Highway Engineering

REVIEWED BY CHARLES J. BENNETT

State Highway Commission, Hartford, Conn.

HIGHWAY ENGINEERING: Rural Roads and Pavements—By George R. Chatburn, A.M., C.E., Professor of Applied Mechanics and Machine Design and Lecturer on Highway Engineering, the University of Nebraska, Lincoln. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. 379; illustrated. $3. 18s. net.

The author defines his work as a textbook suitable for the layman and for particular use by agricultural students. If the purpose of the work is to discourage the layman from becoming a highway expert, the result should be easily achieved since the book abounds in discussions of formulas which would be unintelligible to the ordinary layman.

From the standpoint of the reviewer, the book is a good text for students in highway engineering, but should be studied with the understanding that many of the details in any work of this character are open to discussion as, for instance, on p. 194 the statement is made that in the construction of broken stone roads, the large stone should be at the bottom. There are many cases of successful construction where this rule has been reversed. The student of any engineering work, and particularly a work on highways, should not confine his study entirely to one book.

The author shows a broad knowledge of engineering literature. Information is collected from countless sources, to which due credit is given. In some instances, costs of doing certain classes of work are quoted. These costs are unreliable, as are any costs quoted in a book unless all the conditions under which the work was carried on are stated.

In the discussion of sand-clay roads on p. 154, more attention should be given to the proper clay for binding purposes. Bituminous concrete base is dismissed in three lines, while paving brick manufacture is given careful attention. In other words, as the author truly says, the literature on highway engineering is being written so fast that it is impossible for any student thoroughly to surround the entire subject, or for any author to write in one volume all of the details of highway and pavement construction.

The author's long and careful discussion of concrete road specifications and the selection of materials is of great value as a collection of information on this very important division of highway engineering. The paragraph on costs (p. 285) is subject to the criticism of costs already made, as well as to the objection that costs have risen to such an extent that the estimates based on costs of 1915 would be of little value today. The sections on proportioning concrete, including the use of the maximum density curve, promise to be useful.

The book is well arranged and is a valuable addition to highway engineering literature, particularly in view of the fact that it should convince the layman that the planning and construction of highways is largely an engineering problem not to be solved by the ordinary man in the street. Professor Chatburn is to be congratulated on the clearness of his English and the shortness and directness of his sentences.

Faber's Reinforced-Concrete Design—II

REINFORCED CONCRETE DESIGN: Vol. II. Practice—By Oscar Faber, O.B.E., D.Sc., A.M. Inst. C.E., A.C.G.I., etc, Consulting Engineer, Chief Engineer to Trollope and Colls, London, etc. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 6 x 9 in.; pp. 246; illustrated. $6.50.

No American author is going into the theory of reinforced-concrete design in the elaborate fashion as is Mr. Faber. His first volume has already been referred to in these pages. This second one is a continuance of equal merit, particularly for those who are anxious to get the full mathematical treatment of the more complicated actions in reinforced-concrete frames. The full statement of the conditions of bending moments in continuous beams and the moments in columns take up the first half of the book. The second half is devoted to some specimen calculations, live-load allowances for rolling loads, and shear resistance in reinforced-concrete beams. Extensive appendices have a number of diagrams for the design of concrete beams, formulas and diagrams for bending moments in continuous beams, and the verbatim reproduction of the London County Council regulations for reinforced concrete. In Mr. Faber's first volume there are many things which every so often appear or attempt to appear as new facts in current literature. The same is true of this second volume. Many of the amateurs in reinforced-concrete design would do well to go over both books before they waste too much time in their own mathematical calculations.

For the Concrete User

CONCRETE: Its Manufacture and Use—Milwaukee, Wis.: Koehring Co. Board Cover; 4 x 7 in.; pp. 207; illustrated.

The Koehring Co. realizes that the better concrete users of its machinery produce, the more of its machinery it will be apt to sell. It has, therefore, gotten out the book noted above to instruct the prospective users of machinery not so much in the use of that machinery or in the details of the equipment, as in the proper method of making concrete. The result is an admirable little handbook for the concrete user. The amount of new material in it is disappointingly small, though there are some good new tables on quantities for given lengths of road pavements, etc., and a very good check list for hunting trouble in machinery breakdowns. The main part of the book, on methods of making concrete, however, is the standard information available to the expert in concrete construction. Inasmuch as the book probably will not have as great circulation among the experts as it will among the inexperts in concrete work, the clear statement of these well known facts and the consecutive placing of information are unquestionably worth while.

Travel Sketches of a Mining Engineer

THIS WORLD OF OURS—By J. H. Curle, Author of "The Shadow Show," Etc., New York: George H. Doran Co. Cloth; 6 x 9 in.; pp. 313. $2.50 net.

World travel seems to be the ruling passion of this mining engineer who, "on the right side of forty, and with an assured income, decided to continue seeing the world, as he had been doing since he was a lad, but unhampered by professional duties thenceforth. His book brings together by countries, or larger regions and general routes, many and various travel sketches, telling where he went, what he saw and what he thought or fancied (then or in remembrance) in all parts of the world. Dates are rarely given and the observations of many trips to the same parts are sometimes combined. Only a few short and sketchy chapters are given to the author's youth, university life and mining experiences, and most of even this part of the book consists of travel notes. The volume is entertaining, to some extent instructive and often thought provoking. Most people would find it better to read by occasional snatches than consecutively. That a book containing sketches of so many places and peoples, thumb nail sketches though most of them are, should have no index is a sin of omission for which both author and publisher deserve punishment.

Catalogue of Rare Scientific Books

BIBLIOTHECA CHEMICO-MATHEMATICA: Vol. I and II; Catalog of Works in Many Tongues on Exact and Applied Science, with a Subject-Index—Compiled and Annotated by H. Z. [Heinrich Zeitlinger] and H. C. S. [Henry Cecil Sothern] London: Henry Sotheran & Co. Red Buckram; 6 x 9 in.; pp. 964; illustrated. £3 3s. net.

A wide range of books on chemistry, physics, mathematics and various branches of engineering is included in this handsomely made priced catalog. Many of the volumes are old and rare. The illustrations reproduced are of great interest. A comprehensive index adds greatly to the value of the work—begun in 1906 but continued in the form of a supplement. The volume will be of great interest and value to those whose interest in book collecting or bibliography extends into the field of science.

A New Engineering Journal

"Management Engineering, the Journal of Production," (Roland Press, New York City; $5 a year) is a new monthly edited by L. P. Alford, lately editor of the *American Machinist* and then of *Industrial Management*. E. W. Tree is associate editor and there is an editorial council of 24 prominent engineers and manufacturers. Among the many contributed articles in the first issue are: "The Pioneer Spirit in Engineering," by E. S. Carman; "Basic Principles of Cost Production," by Sanford E. Thompson; "Education for Proprietorship," by Arthur E. Morgan; and "Classifying and Indexing the Clipping File," by Harrison W. Craver. The latter describes the system used under his direction by the Engineering Societies Library. This system has been adopted by the new journal for indexing its contents and the proper index number appears at the head of each article.

PUBLICATIONS RECEIVED

AMERICAN ROAD BUILDERS' ASSOCIATION: Proceedings, 1920—New York: The Association. Paper; 6 x 9 in.; pp. 259. $3.

CALIFORNIA DEPARTMENT OF ENGINEERING: Report, 1919-20. W. F. McClure, State Engineer. Sacramento, Cal.: The Department. Paper; 6 x 9 in.; pp. 156; illustrated.

CHICAGO MUNICIPAL REDUCTION PLANT: Operation, Maintenance and Construction; Report of the Subcommittee on Waste Disposal of the Committee on Efficiency, Economy and Rehabilitation of the City Council of the City of Chicago; Together with a Report of Irwin S. Osborn, Consulting Engineer. Chicago, Ill.: City Council. Paper; 9 x 12 in.; pp. 16; illustrated.

A note based on this report appeared in *Engineering News-Record*, May 19, 1921, p. 856.

CONCRETE DESIGNERS' MANUAL: Tables and Diagrams for the Design of Reinforced Concrete Structures—By George A. Hool, S. B., Consulting Engineer, Professor of Structural Engineering, The University of Wisconsin and Charles S. Whitney, M.C.E., Structural Engineer, Milwaukee, Wis. New York and London: McGraw-Hill Book Co., Inc. Flexible; 6 x 9 in.; pp. 276; illustrated. $4.

DIE AUSNUTZUNG DER WASSERKRAFTE: Technische Und Wirtschaftliche Grundlagen Neuere Bestrebungen Der Kulturländer—Von E. Mattern, Regierungs—Und Baurat in Potsdam Privatdozent An Der Technischen Hochschule Zu Berlin. Dritte Auflage. Leipzig, Germany: Verlag Von Wilhelm Engelmann. Cloth; 8 x 11 in.; pp. 1029; illustrated. Paper; 192 m.; Cloth; 212 m.

Earlier editions of this work on Water Power Development were noted in *Engineering News*, Nov. 15, 1906, p. 524 and Feb. 18, 1909 (p. 18 of Engineering Literature Supplement.) Since the first edition the book has nearly quadrupled in size. The progress of the art in other countries than Germany is noticed. Apparently the world literature of the subject up to 1921 has been searched.

ECONOMICS OF BRIDGEWORK: A Sequel to Bridge Engineering—By J. A. L. Waddell, C.E. (Rens. Poly. Inst.); B.A. Sc., Ma.E., D.Sc. (McGill Univ.); D.E. (Univ. of Neb.); LL.D. (Univ. of Mo.); Kogakuhukushi (Doctor of Eng., Imp. Univ. of Japan.) New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 512; illustrated. $6. 30s. net.

EDUCATIONAL WORK OF THE COMMERCIAL MUSEUM OF PHILADELPHIA—By Charles R. Toothaker, Curator. Washington, D. C.: Dept. of the Interior. Paper; 6 x 9 in.; pp. 28; illustrated. 15c. from Superintendent of Documents.

EIN JAHRHUNDERT DEUTSCHER MASCHINENBAU: Von Der Mechanischen Werkstätte Bis Zur Deutschen Maschinenfabrik, 1819-1919—Von Conrad Matschoss. Berlin, Germany: Julius Springer. Cloth; 9 x 12 in.; pp. 271; illustrated.

ELEMENTS OF MAP PROJECTION: With Applications to Map and Chart Construction—By Charles H. Deetz, Cartographer and Oscar S. Adams, Geodetic Computer, U. S. Coast and Geodetic Survey. Washington, D. C.: The Survey. Paper; 8 x 11 in.; pp. 163; illustrated. 50c. from Superintendent of Documents.

FINANCING AN ENTERPRISE: A Manual of Information and Suggestion—By Hugh R. Conyngton, Chairman of the Board, The Ronald Press Co. In Three Vols. Vol. 1: The Enterprise, pp. 227; Vol. II: The Organization, pp. 203; Vol. III: The Financing, pp. 230. New York: Ronald Press Co. Cloth; 6 x 9 in. $7.

First published in 1907 under the nom de plume, Francis Cooper. A wide range of pertinent topics is discussed.

THE FUNCTIONS OF THE ENGINEERING EXPERIMENT STATION OF THE UNIVERSITY OF ILLINOIS—By Charles Russ Richards. Urbana, Ill.: Engineering Experiment Station, University of Illinois. Paper; 6 x 9 in.; pp. 21.

FURTHER OBSERVATIONS ON THE EOSINMETHYLENE BLUE AGAR—By Max Levine. Reprinted from Journal of the American Water Works Association, March, 1921. Ames, Iowa: Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts. Paper; 6 x 9 in.; pp. 5.

HANDBOOK OF CONSTRUCTION EQUIPMENT: Its Cost and Use—By Richard T. Dana, Consulting Engineer, M. Am. Soc. C. E., Mem. A.I.M. & M.E., etc. New York and London: McGraw-Hill Book Co., Inc. Flexible; 4 x 7 in.; pp. 849; illustrated. $6.

A revised and enlarged edition of "Handbook of Construction Plant," noticed in *Engineering News*, Dec. 24, 1914. Prices as of 1920 are given.

HANDBOOK OF STANDARD DETAILS: For Engineers, Draftsmen and Students—By Charles H. Hughes, Author of "Handbook of Ship Calculations, Construction and Operation." New York and London: D. Appleton & Co. Leatherette; 5 x 7 in.; pp. 312; illustrated. $6.

Has sections on drawings, fastenings, power transmission, pipe, tubes and fittings, rope and chain fittings, miscellaneous details, structural details, useful tables.

THE HARDINGE BRIDGE OVER THE LOWER GANGES AT SARA—By Sir Robert Gales, F.C.H., M. Inst. C. E.; with Supplementary Notes on the Original Project by Sir Francis J. E. Spring, K.C.I.E., M.A.I., M. Inst. C. E. Simla, India: Office of the Chief Engineer with the Railway Board. Paper; 8 x 13 in.; pp. 176; illustrated. 3 Rupees.

Reprint, with additions, of a paper from Inst. C. E., Nov., 1917, describing the construction of a bridge of 15 girder spans of about 345 ft. each and three land spans of 75 ft. each end, carrying a double track railway and a footway. The additional matter includes the original report and estimate made by Sir Francis J. E. Spring in 1903; also an extract from an inspection report on the bridge made in Feb. 1915, prior to its being opened for traffic

I-EISEN UNITE RESONDERER BERUCKS ICHTIGUNG DER BREITFLANSCHIGEN U. DER PARALLELFLANSCHIGEN I-EISEN—Von Dr.-Ing. Richard Sonntag, Regierungsbaumeister a. D., Beratender Ingenieur; V. B. I. in Berlin-Friedrichshagen Berlin, Germany: Verlag des Vereines Deutscher Ingenieure. Paper; 7 x 10 in.; pp. 138; illustrated. 30 m.

AN INTRODUCTION TO MATHEMATICAL ANALYSIS—By Frank Loxley Griffin, Ph.D., Professor of Mathematics, Reed College, Portland, Ore. Boston New York and Chicago: Houghton Mifflin Co. Cloth; 5 x 8 in.; pp. 512; illustrated. $2.75.

THE JERSEY CITY DEVELOPMENT PLAN: Report of the Board of Engineers. (Martin Schreiber, Chairman Engineer, Waterfront Committee, Chamber of Commerce; Philip Guise, M. Am. Soc. C. E., Secretary)—Jersey City, N. J.: The Board. Paper; 9 x 12 in.; pp. 92; illustrated.

Prepared by a board of engineers appointed by the City Commission. Contains recommendations on harbor improvements, steam railroads, streets, housing and zoning, parks, garbage and ashes collection and disposal and local transportation.

JUDGING THE QUALITY OF PORTLAND CEMENT—By Roy J. Colony of the Department of Geology, Columbia University. New York: The Author. Paper; 6 x 9 in.; pp. 10; illustrated.

THE LUMBER INSPECTION RULES: Containing Rules Governing the Manufacture and Inspection of the Different Kinds of Lumber, Weights of Lumber, Comparative Strength of Building Timbers and other Information Useful to the Buyer and Consumer of Lumber—Compiled by Lumber Inspection Rules. Fourth Edition. New York: Lumber Inspection Rules, 229 West 42d St. Flexible; 5 x 6 in.; pp. 341; illustrated. $3.

MODERN METHODS FOR MEASURING THE INTENSITY OF GRAVITY—By Clarence H. Swick, Geodetic Computer, U. S. Coast and Geodetic Survey. Washington, D. C.: The Survey. Paper; 6 x 9 in.; pp. 96; illustrated. 15c. from Superintendent of Documents.

MOTOR TRUCK LOGGING METHODS—By Frederick Malcolm Knapp, Student in the College of Forestry, University of Washington. Seattle, Wash.: Engineering Experiment Station, University of Washington. Paper; 6 x 9 in.; pp. 49; illustrated.

NATIONAL ELECTRICAL SAFETY CODE: Discussion, Oct., 1921—Washington, D. C.: Bureau of Standards. Paper; 5 x 8 in.; pp. 330; illustrated. (Cloth Bound) 40c. from Superintendent of Documents.

ROADWAY AND TRACK—By W. F. Rench, Author of "Simplified Curve and Switch Work." Formerly Supervisor on Pennsylvania Railroad. New York: Simmons-Boardman Publishing Co. Cloth; 6 x 9 in.; pp. 242; illustrated. $3.

PERSPECTIVE: The Old and the New Method—By Archibald Stanley Percival, M.A., M. B., B. C. Cantab, Author of "Geometrical Optics," "Practical Integration," etc. New York and London: Longmans, Green & Co. Cloth; 6 x 9 in.; pp. 42; illustrated. $1.60.

THE PORT OF SHANGHAI: Shanghai Harbour Investigation. Second Edition—Shanghai, China: Whangpoo Conservancy Board. Paper; 8 x 11 in.; pp. 54; illustrated.

PREUSSENS GEWERBEFORDERUNG UND IHRE GROSSEN MANNER. Dargestellt Im Rahmen Der Geschichte des Vereins Zur Beförderung Des Gewerbfleisses 1821-1921—Von Conrad Matschoss. Berlin, Germany: Verlag Des Vereines Deutscher Ingenieure. Paper; 8 x 11 in.; pp. 165; illustrated. 150 m.

SANITARY ENTOMOLOGY: The Entomology of Disease, Hygiene and Sanitation—Edited by William Dwight Pierce, Ph.D., Consulting Entomologist, Formerly Entomologist Southern Field Crop Insect Investigations, U. S. Department of Agriculture Bureau of Entomology. Boston, Mass.: Richard G. Badger. Cloth; 7 x 10 in.; pp. 518; illustrated. $10.

SHANGHAI MUNICIPAL COUNCIL: Report, 1920, Public Works Department. C. H. Godfrey, M. Inst. C. E., Commissioner of Public Works. Shanghai, China: Public Works Dept. Paper; 8 x 13 in.; pp. 20; illustrated.

SOME CONDITIONS AFFECTING THE USEFULNESS OF IRON OXIDE FOR CITY GAS PURIFICATION—By Wm. A. Dunkley, Illinois Coal Mining Investigations Co-operative Agreement. (This Report was Prepared Under a Co-operative Agreement Between the Engineering Experiment Station of the University of Illinois, The Illinois State Geological Survey, and the U. S. Bureau of Mines.) Urbana, Ill.: Engineering Experiment Station, University of Illinois. Paper: 6 x 9 in.; pp. 62; illustrated.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1920—Washington, D. C.: Bureau of Foreign and Domestic Commerce. Cloth; 6 x 9 in.; pp. 874. (Paper Covers) 50c. from Superintendent of Documents.

THE STABILITY OF HILL SLOPES—By C. S. Fox, B.Sc. (Birm.), M.I.M.E., F.G.S., Officiating Superintendent, Geological Survey of India; with a Prefatory Note by Major E. P. Anderson, D.S.O., R.E., Engineer-in-Chief, Hardwar-Karanprayag Survey. Simla, India: Office of the Chief Engineer with the Railway Board. Paper; 8 x 13 in.; pp. 6; illustrated. 4 Annas.

TIMBER DEPLETION AND THE ANSWER: A Summary of the Report on Timber Depletion and Related Subjects Prepared in Response to Senate Resolution 311. Contribution from the Forest Service, William B. Greeley, Forester. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 in.; pp. 16. 5c. from Superintendent of Documents.

WAR WORK OF THE BUREAU OF STANDARDS, APRIL, 1921—Washington, D. C., Bureau of Standards. Paper; 6 x 9 in.; pp. 299; illustrated. 70c. from Superintendent of Documents.

ZEITSCHRIFT FUR ANGEWANDTE MATHEMATIK UND MECHANIK—Herausgegeben Von Professor R. Von Mises. Band 1, Heft 2—Berlin, Germany: Verlag Des Vereines Deutscher Ingenieure. Paper; 8 x 11 in.; pp. 160; illustrated.

ZEITSCHRIFT FUR METALLKUNDE: Herausgegeben Von Der Deutschen Gesellschaft Für Metallkunde Im Verein Deutscher Ingenieur Schriftleitung—Professor Dr. W. Guertler Und Dipl.-Ing. H. Groeck. Berlin, Germany: Verlag Des Vereines Deutscher Ingenieur. Paper; 8 x 11 in.; pp. 10; illustrated.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

Shearing Stresses in Timber Trestle Stringers

Sir—Subcommittee 2 of the Committee on Wooden Bridges and Trestles of the American Railway Engineering Association has before it the subject of plans for trestles to be submitted to the next convention for approval. One of the subjects over which there appears to be a wide difference of opinion is the stress to be permitted in longitudinal shear. The stresses under this head adopted by the last convention are 125 lb. per sq.in. for dense pine and 100 lb. per sq.in. for Douglas fir. In practice the different railroads permit as high as 220 lb. per sq.in. in design for dense pine, with no allowance for impact.

This wide disparity between theory and practice is explained by some as due to the way longitudinal shear is computed. It is claimed that the usual method is to apply the load at the same point as when computing vertical shear, that there will be no longitudinal shear where there is no deflection, that a load applied to determine vertical shear will never cause longitudinal shear, and that the timber will fail from direct compression long before longitudinal shear will occur. It is contended that to obtain longitudinal shear the load should be applied as in the tests at the laboratory or in the manner which will produce maximum deflection. The imposed load of an engine moving across the deck of a trestle is not fixed.

The committee would like to have the views of as many as care to write on this subject. Is the accepted method of fiuring longitudinal shear just to the timber, and will it give us a true indication of the strength of the timber to resist that stress in service? Taking panel lengths of 12 ft. and 16 ft. and the engines now in use, where should the engine be placed to impose the maximum load in longitudinal.

A. M. VAN AUKEN,
Chairman Sub-committee 2.

Chicago, July 6.

Dam Failure Danger Exaggerated

Sir—Certain items of news and editorial comment which have appeared in the public press and in engineering periodicals apropos of the recent flood at Pueblo prompt me to set forth some of my impressions in regard to them. I am referring particularly to an editorial of *Engineering and Contracting*, June 8, 1921, an editorial of *Engineering News-Record*, June 16, 1921, and an article appearing in *Literary Digest*, July 9, 1921.

The importance of dam design and construction probably cannot be overrated. In general dams should be built so as to be safe—safe with adequate margin. Where human life would be endangered by the failure of a dam, no cause for reasonable doubt should be permitted to remain unremedied. True, there are circumstances where a lesser margin is justifiable. Thus, for a dam which is the means of storing only a relatively small quantity of water and below which there are many miles of uninhabited valley or canyons, commercial considerations may possibly be allowed to govern. The failure of Stony River dam, for instance, caused no loss of life and little property damage, mainly because thirty miles and more of watercourse lay between the dam and any considerable development or settlement which could be damaged. Perhaps the Schaeffer dam, on Beaver Creek above Pueblo, was of the kind where a lesser margin was justifiable.

For the greater part, however, even economic factors usually require absolute safety of investment. In any event questions of doubt should be resolved in favor of safety. Governmental supervision of dams, which cannot be successfully challenged from the standpoint of public welfare, should see to it that the adequacy of a dam is measured by the proper criterion. Where absolute safety is essential and consequent cost is incompatible with commercial success, the dam should not be built.

Dam design is by no means the simple problem that earlier textbooks might lead one to think. Especially is this true with reference to foundation problems which are inseparably a part of dam design. But the difficulties are not insuperable. Given tolerably good foundation conditions, dams can be made safe. Both editorials in point refer to alleged difficulties of determining the loading to which a dam will be subjected. It is implied that, unlike bridge design, the loads of dams must be "guessed at" or at least are subject to a "factor of ignorance." On the contrary, maximum loads of dams can be predetermined, and appropriate provision made in design, with greater assurance of adequacy than in the case of a bridge. The discussion of such a statement might warrant an extended article, but suffice it for the present to point out that increases in bridge loading not dreamed of by the designer have caused thousands of highway and railroad bridges to be superseded and many to collapse. The difficulties in dam design are rather to be found in the matter of foundations, and even in this respect one must not forget that bridges have their foundation problems and their failures.

However, it is not my object to argue that bridges or other structures should be subject to as much care in design and construction as dams. Instead, let us agree that there have been "too many dam failures" (as *Literary Digest* puts it), but that dams can be properly designed and constructed and that the requirements for safety can be adequately met. Is then the record of the past not sufficiently bad without needless exaggeration?

Ever since the days of the Johnstown flood, stories of dams which have failed or are about to fail, stories of horsemen speeding down valleys to warn the inhabitants, stories of tremendous damage and loss of life caused by dam failures, real and fancied, have been favored by the public press. More frequently than not, accounts of dam failures have been grossly exaggerated. These exaggerations are harmful, not merely to the engineering profession, but what is much more important, to the community at large. For the community must always remain dependent in large measure upon engineering structures. In days gone by pioneering development in the United States consisted largely of railroad construction, but since then more and more our largest public works have had to do with water. Inland waterway development, irrigation, flood control, water-power development all are important phases of engineering construction, directly or indirectly adding to the real wealth of our nation. And in most cases these are impossible of accomplishment without dams. The same is frequently true of water supplies.

Therefore, it seems to me that great harm is done unjustifiably to the engineer and to the community when the editor of *Engineering and Contracting* predicates an editorial on the subject of dam failures upon unconfirmed reports from Colorado that "a large part of the recent flood damage to life and property was due to dam failures"; likewise, when *Literary Digest*, quoting and taking its cue from the above-mentioned editorial, supplements copied material and its own comments with a photograph bearing the caption: "When the dams fail: Wreckage in the railroad yards at Pueblo." Even hydraulic engineers, such as I, have been somewhat surprised to find that evidently there is authoritative record of the failure of only one dam during the Arkansas River basin flood of early June and that that one dam (the Schaeffer reservoir dam), according to official report, did not fail until thirty hours after the peak of the Arkansas flood had reached Pueblo.

It is unfortunate that the representatives of the State Engineer of Colorado have apparently been unable so far to obtain any reliable record of the effect at Pueblo of the release of the contents of the Schaeffer reservoir. It is interesting to note, however, that the 3,100-acre-foot capacity of that reservoir would not have been sufficient to maintain the estimated flood peak discharge of the Arkansas at Pueblo for more than twenty-three minutes.

F. W. SCHEIDENHELM, Consulting Engineer.

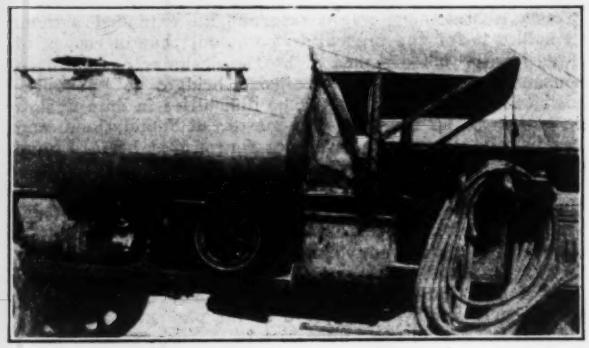
New York, July 13.

HINTS FOR THE CONTRACTOR

Portable Water Tank for Concrete Paving

By Walter B. Cannon
Lankershim, Cal.

IN DOING odd jobs of concreting on the highway it is often difficult to secure water. The illustration shows a 1,200-gal. tank mounted on a 5-ton truck, with a 1½-hp. gasoline engine driving a 1-in. centrifugal pump



WATER TANK OUTFIT FOR PAVING CONSTRUCTION

mounted on the side. The pump is piped so that it can load the tank from ditch or pond or it can be made to pump from the tank.

The engine can be started and will run indefinitely without attention, and whenever water is wanted all that is necessary is to open a valve and the pressure is just about right for furnishing a mixer with water.

Protecting Eyes in Electric Welding

By C. W. Geiger
San Francisco, Cal.

A DEVICE developed by an employee of the Market Street Railway of San Francisco and shown in the accompanying photograph, affords protection for the eyes of an electric welder without the use of the usual metal head dress. It consists of a board slotted near one end for the insertion of colored glasses which are held in place by a clamp. The operator holds the board in the proper position with his left hand, while his right hand manipulates the welding tool.

BOARD AND COLORED GLASS DO AWAY WITH HELMET

This device does not prevent him from glancing up quickly to observe approaching traffic. In some locations where an assistant would otherwise be required, with this device a single operator can safely carry on the welding operation because he always has an unobstructed view in all directions. While the operator is using both hands for removing box, tools, etc., the board is allowed to hang from the strap by which it is slung around his neck. The device has proved so popular that the company is now using it for all of its welders who have field work to do.

Boiler Becomes Reservoir When Steam Shovels Use Compressed Air

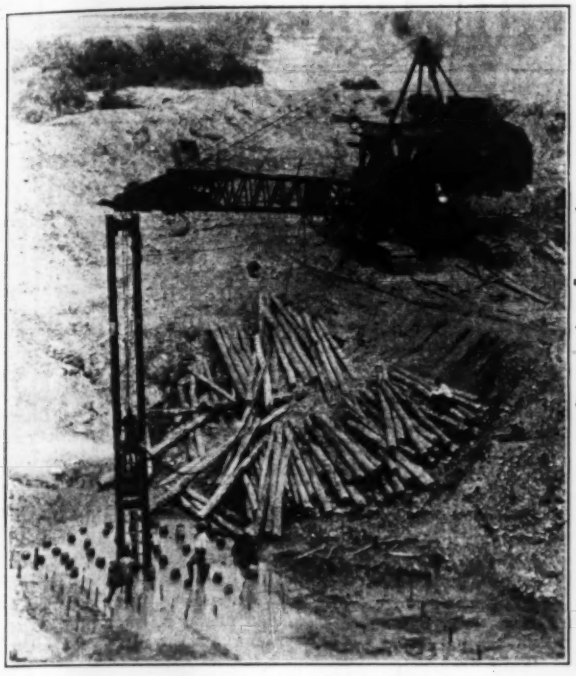
STEAM shovels operated by compressed air were used for handling muck in the tunnels of the Kerckhoff hydro-electric project in California. The air supply was delivered through a short flexible coupling from the air-line which served the drills at the heading. Before the shots in the heading could be fired of course it was necessary to move the shovel back so as to avoid damage from flying rock. In order to do this without using long hose connections, compressed air was turned into the boiler and this was drawn upon as a reservoir of motive power. It was found that the boiler capacity was sufficient to move the shovel back the required distance, usually several hundred feet, and return it to the muck pile after the shot.

Dragline Drives Fifty-four Piles In One Shift of 10 Hours

By C. H. Eiffert
Division Engineer, Miami Conservancy District

FROM thirty to forty piles on an average, with fifty-four as a maximum number, were driven per 10-hour shift by a dragline excavator rigged as a pile-driver on the construction of the Black Street bridge at Hamilton, Ohio, by the Miami Conservancy District. Eight hundred and sixty foundation piles for piers and abutments, as well as piles to support falsework, were driven in this manner. The foundation piles had an average penetration of 17 ft. in gravel.

In rigging up the excavator for this work the leads, built of 6 x 8-in. timbers about 33 ft. long, were lashed to the end of the boom with wire rope, and were raised or lowered by raising or lowering the boom. A steam hammer weighing 3,800 lb. was used, the weight of the striking parts being 1,800 lb. The hammer was operated by the hoist line running over the sheave at the end of the boom. Piles were pulled into the leads by the dragline cable running through a pulley near the top of the leads. The dragline excavator had a 70-ft. boom and was the same machine used for building cofferdams and excavating for foundations.



DRAGLINE PILEDRIVER OPERATING IN MIAMI CONSERVANCY WORK

When ready to drive piling, the boom was lowered to the ground, the leads were attached and the hammer was drawn into them. The leads were then spotted over the location of the pile to be driven and lowered, the weight of the boom being allowed to rest on them, forcing the lower projecting ends of the 6 x 8's from 2 to 3 ft. into the ground. This held them in place at the bottom, the boom holding them at the top.

Weights of Forms for Filter Covering Determined From Models

By Perry Thompson
Sanitary Engineer, Yonkers, New York

IN CONNECTION with covering two open sand filters at Yonkers, N. Y., with groined and barrel arches the contractors wished to know in advance the weights of forms and centers they were proposing, and at the same time to determine other doubtful points and ensure practicability. Accordingly, models of whitewood, one-eighth size, were constructed. This proved a very convenient scale since whitewood may be had $\frac{1}{8}$ in. and $\frac{1}{4}$ in. thick, representing 1-in. and 2-in. lumber.

The plan of subdivision is shown in the sketch, where the solid lines represent the form limits or joints, and the dotted lines represent the ridges, as shown in the photographs. It will be noticed that at the wall corner sections and along the north and south walls the diagonals do not meet. This is because they are at angles of 45 deg., an arrangement which made them easier to construct, while the distances are unequal; the result of original filter dimensions being such that no convenient common divisor could be found. Since the arches are practically level at the crowns no difficulty resulted.

Form *A* was heaviest and weighed 1.144 lb. Form *D* was lightest and weighed 0.645 lb. Multiplying by 512 (= 8³) we get the weights of full-sized forms of whitewood, but as the forms are being made of

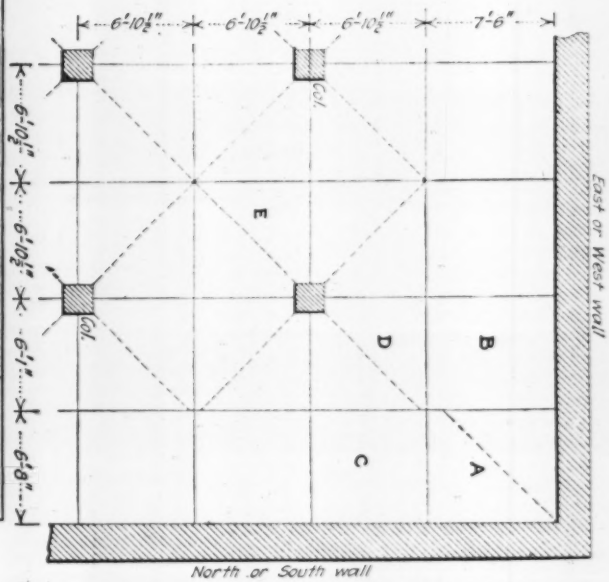


FIG. 1. PLAN OF SUBDIVISION FOR GROINED ARCH CENTERS

long-leaf yellow pine it is necessary to multiply again by the ratio of weight of the latter to the former, or 1.45, which gives the weights in dry long-leaf yellow pine. Adding 3 per cent for moisture we get for *A* 875 lb., for *B* 705 lb., for *C* 735 lb., for *D* 495 lb., for *E* 635 lb. and for *F* 825 lb.

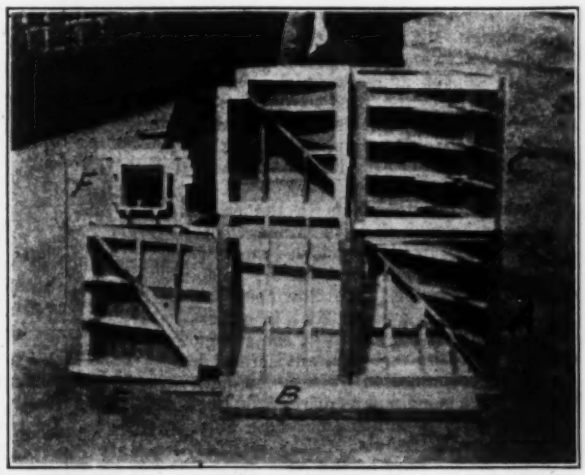


FIG. 2. UNDERSIDE OF FORM MODEL
Complete arch and groin section on right, quarter groin cap on left and column form above.

The contractor expects that six or eight husky laborers will be able to handle the forms, which will be assembled regardless of weather in an open shed adjoining the filters.

NEWS OF THE WEEK

New York, July 21, 1921

Tunnel Engineers' Dismissal Unjustified, A. A. E. Finds

Jersey Commission's Action Held to Be Prejudicial to Tunnel Enterprise and Public Welfare

That the New Jersey Interstate Bridge and Tunnel Commission, in the manner of its attempted dismissal of the board of consulting engineers for the Hudson River vehicular tunnel, acted in a way prejudicial to the tunnel enterprise and to the public welfare and that other engineers, in attempting to fill positions thus made available, have been lacking in good taste and a fine appreciation of professional courtesy and ethics, are the main findings of the committee, consisting of F. Lavis, James F. Sanborn, and John P. Hogan, appointed June 17, by the New York Chapter of the American Association of Engineers to investigate and report on the situation created May 14 by the New Jersey commission in its passage, without the concurrence of the New York commission, of a resolution terminating the consulting services of Col. William J. Wilgus, John A. Bensel, Prof. Wm. H. Burr, Edward A. Byrne, J. Vipond Davies, and Col. George L. Watson. The committee's report, dated July 12, was approved last week by the board of directors of the local chapter of the association.

COMMITTEE GATHERS EVIDENCE

Prior to the submission of its findings, the committee sought the views of Col. Wilgus, chairman of the consulting board, T. Albeus Adams, chairman of the New Jersey tunnel commission, and George M. Wells and St. John Clarke, the two engineers last named having accepted appointments as technical advisers to the Jersey commission shortly after the dismissal of the consulting board; all complied with the committee's request for information except Mr. Adams.

After stating the facts in the case, which has been dealt with at length in the news columns of previous issues of *Engineering News-Record*, the A. A. E. committee expresses the following opinion: "It is very evident that if either commission felt aggrieved at the action or attitude of its technical advisers and the other commission refused to act, it must have some means of redress, but so far as your committee has been able to discover, there was little, if any, attempt on the part of the New Jersey board to settle such grievance as they may have had in agreement with the New York commission."

After calling attention to the fact that the New Jersey commission had refused officially to give to the committee any information, on the ostensible

(Continued on p. 125)

New Federal-Aid Road Funds May Be Withheld

(Washington Correspondence)

Highway legislation is faced by a new danger. The reasons which caused the President to oppose soldier-bonus legislation are thought to have actuated him to take a similar attitude with respect to the $100,000,000 appropriation being asked for highway development. While there has been no announcement from the White House on the subject, it is believed that the President prefers that this appropriation be delayed until the condition of the Treasury has improved.

Leaders in both the Senate and House have not been friendly at any time during the session to the suggestion that additional funds be appropriated at this time for federal-aid work. During recent weeks, with the more general recognition that the Treasury situation is really serious, this attitude has come to be regarded in a more sympathetic way. For that reason it no longer is the difference of opinion between those favoring the Townsend bill or the Dowell bill that threatens to delay highway legislation—it is the apparent crystalization of sentiment in favor of restricting appropriations regardless of their urgency.

St. Lawrence Waterway Report Made

Colonel W. P. Wooten, Corps of Engineers, U. S. A., and W. A. Bowden, chief engineer of the Canadian Department of Railways and Canals, have made their joint report to the International Joint Commission on the engineering features and possibilities of the Great Lakes-St. Lawrence waterway. An estimated cost of $252,728,200 is given for a 25-ft. depth, which includes a series of nine locks, 33 miles of canals, 10½ miles of lake channel and 108 miles of river channel, as well as the development of 1,464,000 hp. at Long Sault rapids. Provision is made for canal bottoms 200 ft. wide and open channels 450 ft. wide with locks 864 x 80 ft. The total fall from Lake Ontario to Montreal is 220 ft.

British Experts to Survey Russian Harbors

As a result of a request made to the British Board of Trade by the Soviet Russian Government, two British engineers are to go to Russia to survey harbors and maintain their safety for navigation. V. Havelock Case, a dock and harbor expert, and D. B. Male, an authority on salvage operations, have been selected for the work. The Soviet Government requested the assistance of the British Board of Trade, which consulted the London Salvage Co.

Rental Fees for Concrete Road Roller Reduced

Macon Co. Announces Change in Schedule, Following Criticism by Contractors and Engineers

Following the decision on March 2 of the U. S. District Court of Georgia, supporting the validity of the patents of the Macon Concrete Road Roller Co., covering its device and process for finishing concrete pavement with a light weight hand roller of small diameter and relatively great length (see *Engineering News-Record*, April 7, p. 610) contractors and highway engineers are expressing dissatisfaction at what are claimed to be unreasonable charges for the use of the method. In fact, the Associated Pennsylvania Highway Contractors, the local organization of the Associated General Contractors of America, has urged its members to refuse payment of the present license fees demanded and to consult with the association's local office at Harrisburg in cases where disputes as to payment arise. It is further understood that the Pennsylvania State Highway Department, in the light of the alleged high rental costs, has under consideration a change in its specifications whereby the use of the light roller method of finishing concrete paving surfaces will be eliminated.

OLD RENTAL BASIS

According to the Macon company's form of contract, the rental basis for the road roller is ¼c. per square yard which, for an 18-ft. highway, amounts to more than $50 per mile. A minimum charge of $100 is demanded for the lease of the roller on contracts amounting to 10,000 sq.yd. or more, while on smaller contracts than the foregoing a payment of $2 per day is specified, with a minimum charge of $50 and a cash deposit of $100. It has been estimated that the cost of manufacture of the roller itself is only about $10 or $15 and that in their demands for royalties at the rate of $50 per mile the lessors are asking more than a reasonable amount for the use of their device and process.

It appears that the method is generally acknowledged as a satisfactory one, the chief objection being on the grounds of excessively high rental charges.

[*Copy of the foregoing statement was sent by "Engineering News-Record" to the Macon Concrete Road Roller Co., June 29, with request for any comment the company might care to make. The following reply, dated July 11, has been received*—EDITOR.]

"Following yours of June 29 and my communication to you on July 2 I beg to state that we have endeavored to

meet the views of both highway commissions, engineers, and contractors, and have changed our rental terms in accordance with the sketch as herewith inclosed. We realize that we have a most useful device for finishing concrete pavements and we were under the impression that the rental charge of ½c per yard would be low cost for the great value derived from its method. However, we were open to conviction and as soon as we discovered that this principle was unpopular we have endeavored to change the terms in accordance with their views.

"We will notify our agents and contractors of this change and will try to co-operate with them if you will be kind enough to make some mention of this change in *Engineering News-Record* in which we have been running an advertisement and securing a great many inquiries."

The new schedule of rental fees referred to in the foregoing letter is as follows:

"(1) Basis of rental will be $150 per year per roller or when used less than a year $30 per month for the first month and $20 per month for each additional month, with a cash deposit of $150 and a minimum charge of $50.

"(2) When two or more rollers are used and leased to the same contractor and additional charge of $75 per year will be made for each additional roller or when used less than a year $15 per month or portion of a month with a cash deposit of $75.

"(3) On small contracts where roller is used for a period of sixty days or less a cash deposit of $100 will be required and a minimum charge of $50.

"(4) Difference in amount if any to be refunded as of the day roller is delivered to our authorized agent or to the Express or Railway Company for shipment.

"(5) Where contractors deliberately infringe on our roller or process a much higher rental will be demanded."

New York State Soldier Preference Law Held Invalid

A New York State law providing that any person who had taken and passed a civil service examination for promotion in the state, county or city service and who subsequently "entered the military or naval service of the United States . . . shall be preferred for any appointment or promotion thereafter made in such grade in the department in which he shall be employed" was held invalid by the Court of Appeals of New York State on July 14. The law had been upheld by the State Supreme Court and by the Appellate Division.

It was contended that the statute provided no standard of army or navy service, so that even one who had been dishonorably discharged would have equal benefit with one who had performed long and valuable service; also that the law nullified the original act setting up a uniform method of promotion.

Hetch Hetchy Tunnel Headings Advance 2,780 Ft. in June

Eight headings of the tunnel in the mountain division of the Hetch Hetchy project were driven a total distance of 2780 ft. during the month of June, this progress being made without the loss of a single round of shots at any heading while working on regular schedules. The regular schedule was suspended two days at the Big Creek headings while engineers were plumbing the shaft and five days on the east Big Creek heading during timbering of the section.

The footage in the several headings was as follows: Early Intake, 361 ft.; South Fork, east, 322 ft.; South Fork, west, 319 ft.; Adit 5-6, east and west, 611 ft.; Big Creek, east, 270 ft.; Big Creek, west, 357 ft.; Priest, 540 ft.; total, 2780 ft. The three headings last named are of the smaller section, i.e., 10 ft. 3 in. in diameter. All the others are the larger unlined section, which has a diameter of 13 ft. 8 in. The two headings being driven from adit 5-6 are worked alternately, that is, the shifts go from one heading to the other and only three crews are used on the three shifts that work both headings. The Big Creek headings have to be reached through a shaft 677 ft. deep.

The 18 miles of tunnel in the mountain division of this project are under contract to the Construction Co. of North America.

Old Chicago Bridge Removed

The Rush St. swing bridge over the Chicago River, built in 1874 at a cost of $50,000 has been sold for junk and pulled down, having been superseded by the new Michigan Ave. bascule bridge. The old structure was 240 ft. long and 60 ft. wide, with three trusses carrying the two roadways and outside sidewalks. It was operated by steam until 1900, when electric operation was introduced. For dismantling, the bridge was swung open and blocked up on the protection pier, being then cut up by oxy-acetylene torches and the pieces loaded into barges by a derrick. The bridge was purchased and dismantled by the Ketler-Elliott Co., which paid $500 for it as old metal.

Street Cleaning by Contract to End Dec. 31 at Philadelphia

A pending proposal that all street cleaning work in Philadelphia be done by the City on and after Oct. 1, advocated by Director of Public Works Caven and Mayor Moore, was defeated 13 to 8, by the City Council of Philadelphia on June 27, and Jan. 1, 1922, was substituted as the date for complete change from contract to city work. A portion of the work has been done by the city since Jan. 1 of this year and the remainder under contracts giving the city the option of cancelling them Oct. 1. It was estimated that a change from contract to city work would save the city $150,000 during the last three months of the year.

Louisiana Revises Motor Vehicle Taxes

Constitutional Convention Fixes $15 for Autos and $25 for Trucks as Minimum Fees

(By M. C. Huckaby, Baton Rouge, La.)

There has just come to a close in Louisiana the session of the unlimited Constitutional Convention and among the outstanding features of its work is provision for the first real road-building program that the State has ever had. It is based on a "pay-as-you-go" policy rather than upon long-term bond issues.

Several states are now financing their road systems at the expense of the automobiles and trucks, and tax on gasoline has been proposed. The new policy in Louisiana is a combination of the two and may seem to some to be rather drastic. Quoting from the new Constitution:

"The Legislature shall impose a license tax upon all motor vehicles as follows:

"On automobiles for private use there shall be imposed an annual minimum license tax at fifteen ($15) dollars, said license tax to be graded up from this amount based upon horsepower;

"On trucks or automobiles used for the transportation of passengers or freight, or for the purpose of the delivery or carrying of goods or merchandise, there shall be imposed and annual minimum license tax of twenty-five ($25) dollars, said license to be graded up from this amount based upon both horsepower and carrying capacity.

"On all other vehicles using the public roads, the Legislature is authorized to impose an annual graded license tax based upon carrying capacity"

Tax on Gasoline

On gasoline, when sold and used in Louisiana, there is to be levied a tax not to exceed 2c. per gallon while on kerosene and other fuels used for the purpose of generating motive power the Legislature may also impose a tax.

It is estimated that a general highway fund of $4,000,000 to $5,000,000 a year will be received from the above sources and that the funds raised by local districts will bring the amount up to $10,000,000 to $12,000,000 a year for all road purposes throughout the State. The State will not pay any interest on long term bonds. In order that this might be made stronger, the further provision was inserted:

"No debt shall be created, or certificates of indebtedness or bonds issued, to be paid in the future out of the proceeds realized from any state tax or license to be collected under and by virtue of this ordinance, or imposed thereunder by the Legislature, but the said license and taxes shall be collected from year to year and expended for the purpose of construction and maintenance of the system of state highways and bridges."

The schedule of assessments or fees levied on the several types of vehicles will rest with the Legislature which

will meet in special session Sept. 6. It naturally follows, though, that, if the minimum fees are set on the smallest vehicles and graded up in proportion, the change will be considerably felt by the automobile and truck people. The old law assessed a flat rate of $7.50 on trucks and 25c. a horse power on automobiles, using the S.A.E. formula for computing horse power, which will, no doubt, be thrown out and some other method adopted that will in a measure approach the object sought in arriving at some equitable and just method of assessment.

It is believed by many that the Legislature may reorganize the state highway department.

Heavy Rains Start Movement of Pittsburgh Slide

Some movement of the slide of last November at Kirkpatrick St. and Bigelow Boulevard, Pittsburgh, developed during the last few weeks as the result of heavy rains. On June 24, according to C. M. Reppert, chief engineer of the department of public works, there was a heavy rainfall, reaching "cloudburst" intensity in the Bigelow Boulevard district and flooding the boulevard roadway and the temporary bridge over the slide. The fill in the old ravine of Jones Hollow at the foot of Kirkpatrick St. became saturated. When the rain stopped, after several days, discoloration and thin, soupy material coming to the surface made it evident that underground water was coming through the rock face into the old fill. Subsidence of the upper part of the slide then began and gradually extended downhill.

In the earlier part of the trouble the Pennsylvania R.R. put shovels to work dipping out the thin, supersaturated material. Later a general movement occurred which carried the toe of the slide as far as the first main track, but no heaving of the ground occurred. Where the boulevard crosses the head of the slide it was kept open by blocking up the pile trestle built last October as a temporary crossing over the subsiding ground. Its settlement was at times quite marked, particularly during one night; the maximum settlement was 27 in. The structure rests on piles up to 60 ft. long, which generally pass through clay to rock; apparently they failed from their points slipping on the rock surface.

Operations to reclaim the slide have been in progress for some time under a force account contract with the John F. Casey Co. Up to the present this work has comprised the installation of a drainage system to take care of the surface water and to cut off as much as possible of the underground water passing through the fill from the rock surface. This work is now about completed, and when in service is believed to be able to take care of any emergency which may arise. Plans for the restoration of the boulevard over the head of the slide are being developed and will probably be issued shortly.

New Bids Received for Hudson Vehicle Tunnel

Following the rejection of all bids opened in New York City July 12 for the construction of the Jersey ventilating shafts of the Hudson River vehicular tunnel, new bids were received on July 19 from six contractors, the low total of $371,000 being submitted by the Shaft Construction Co., New York. This is the third time that the Jersey shaft contract has been advertised. The first call for bids, to be opened on March 29, was annulled because of differences between the New York and the New Jersey commissions regarding the widening of certain streets in Jersey City.

The rejection of all bids received last week was the result of a peculiar set of circumstances arising out of the late delivery of the certified check from the low bidder, the Holbrook, Cabot & Rollins Corp., whose price for the work totaled about $380,000 as against $428,000, the next lowest bid, received from the Jocylen Construction Co. of Bayonne, N. J. Shortly before 3 o'clock, the time set for receiving bids, a messenger from the Holbrook, Cabot & Rollins Corp., arrived at the commission's offices with that firm's bid on the Jersey shaft work. The messenger, however, had neglected to bring a certified check, as required. It is understood that the check had been made out, but through an oversight had not been brought to the tunnel commission's offices by the contractor's messenger. Three o'clock arrived, and in spite of urgent telephone calls to the Holbrook, Cabot & Rollins office for the certified check, that document did not arrive until about 3:20 p.m.

A Question of Time

The two commissions then proceeded to a reading of the bids received. When the Holbrook, Cabot & Rollins bid was reached an objection to its reading was voiced by the representative of the Jocylen Construction Co., on the ground that the certified check required to accompany all bids had not been received before the time of bidding closed.

A point then was raised as to whether the commission's announcement of three o'clock should be interpreted as daylight-saving or Eastern standard time. It is understood that counsel ruled that Eastern standard time should govern, and under this ruling the Holbrook, Cabot & Rollins bid and check arrived on time. In newspaper advertisements of the contract, however, it was specifically stated that bids would close at 3 p.m. daylight-saving time. In spite of objections, the Holbrook, Cabot & Rollins bid was read with those from nine other contractors.

Immediately after the canvassing of the bids, the tunnel commission members met. It was brought out in their discussion that acceptance of the low bid of Holbrook, Cabot & Rollins would probably involve the commission in a law suit brought by the second lowest bidder, while if an award of the contract were made to the Jocylen Co., the commissions might be charged with irregular procedure in awarding a contract at a price almost $50,000 in excess of the low bid. The two commissions finally decided that the best way of avoiding trouble would be to reject all bids and call for new bids one week later, on July 19.

Creosoted Wood Floor Responsible for Pittsburgh Bridge Fire

Details concerning the construction of the Thirtieth St. bridge over the Allegheny River, Pittsburgh, which was destroyed by fire on July 8, have been supplied by J. G. Chalfant, county engineer, as follows: The bridge was a continuous truss over the three spans of the south or main channel portion, and was built by Gustav Lindenthal in 1887-88 for a bridge corporation. It remained a tool bridge until March 16, 1911, when Allegheny County purchased it; since then it has been a free bridge. The channel span was 304 ft. 8 in. long center to center of piers, and the north and south spans each 228 ft. 6 in. center of pier to end bearings. The trusses were spaced 22 ft. apart on centers, giving a 19-ft. clear roadway, with a 6-ft. sidewalk on the downstream or west side of the bridge.

At the time the county condemned the bridge, the roadway floor was carried on timbers resting on the bottom chords of the trusses, with longitudinal joists and oak cross-planking. This floor was replaced in 1914 with a creosoted pine floor, consisting of 5 x 16-in. timbers about 2 ft. 4½ in. on centers, 4-in. plank laid longitudinally, and 3½-in. wood block. The blocks were treated with 30 lb. of creosote oil per cubic foot, and the timbers and plant with 14 lb. per cubic foot. The joints in the wood block pavement were poured with bituminous filler. This floor had been found too flexible under heavy traffic, and a contract had been awarded for additional timbers to be placed between the original 5 x 16-in. timbers; since the fire this contract has been cancelled.

Fire was discovered by a workman employed by the county on bridge repair at 12:35 p.m., July 8, near the south end of the channel span. At this time the fire had gained considerable headway, as the flames were coming up over the side of the floor. Alarm was turned in promptly from both ends of the bridge, and fire equipment was on the scene in about 5 to 8 minutes, but evidently was unable to reach the fire under the floor, as the channel span and the south span were both in the river at 1:05 p.m. The north span is still standing and will probably be used for foot traffic in connection with a temporary suspension bridge on the old masonry.

The workman who discovered the fire advanced the theory that it had been occasioned by a leak in a gas line on the upstream side of the bridge. He had no facts to substantiate his theory, and the county engineer has not been able to determine the cause of the fire.

Bureau of Standards Building 10-Ft. Wind Tunnel

The aerodynamic section of the Bureau of Standards is constructing a new wind tunnel, 10 ft. in diameter, the bureau has just announced. The design for the tunnel is completed and material for construction is being assembled. Completion of the tunnel will give the bureau exceptional facilities for all research involving a study of the behavior of objects in a wind stream.

Oppose 10-Ton Truck Weight Limit

A movement has been started to repeal the recent law enacted by the Ohio Legislature limiting motor trucks and their loads to 10 tons. The law becomes effective in August. It reduces to a 10-ton limit the former permissible maximum gross load of 14 tons. Automobile associations, truck owners and contractors are opposing the new restrictions.

Additional Candidates Named for Staten Island Tunnel

The Board of Estimate and Apportionment of New York City, up to date has failed to approve the recommendations which its chief engineer, Arthur S. Tuttle, made for the engineering personnel of the proposed Staten Island tunnel under New York Harbor. As noted in the July 7 issue of this journal, p. 37, the chief engineer recommended for the Staten Island work the appointment of Col. William J. Wilgus and Frederick C. Noble as consulting engineers, Jesse B. Snow as tunnel engineer, Charles B. Drew as principal assistant engineer, W. McK. Griffin as resident engineer, and Alfred E. Hill as designing engineer. In opposition to the first three candidates named above, it is understood that the Board of Estimate has under consideration the names of Henry B. Seaman and John F. Sullivan, as consulting engineers, and Robert W. Creuzbaur as tunnel engineer. Each of the consulting engineers to receive a yearly salary of $10,000 and the tunnel engineer $12,000.

Mr. Seaman is a former chief engineer of the New York Public Service Commission in which position he served three years, resigning to enter private practice. During the war he served as supervising engineer of the emergency plant extension for the torpedo boat destroyer program of the U. S. Navy Department, having charge of construction of thirty-five plants in various parts of the country.

Mr. Creuzbaur is a consulting engineer and a former technical adviser on public works to the Borough of Brooklyn, New York. He has also served in a number of New York City's engineering departments. During the war he was for two years with the Emergency Fleet Corporation as consulting engineer in connection with the plants at Hog Island, Bristol, Pa., and Newark, N. J.

Fire Destroys Seattle Wharves Causing $400,000 Loss

Fire, supposed to have started from a spark dropped by a railway locomotive, caused a loss of approximately $400,000 to the Harbor Island plant of the East Waterway Warehouse & Dock Co. in Seattle July 9. The loss is entirely covered by insurance. About $2,000,000 worth of property was endangered by the fire, which started midway of the long wharf and spread underneath the planking and among the creosoted piles with great rapidity. The flames destroyed 900 ft. of open wharf, and 600 ft. of wharf attached to the No. 2 warehouse. Work of repairs will be gotten under way immediately.

Henry Ford Offers to Buy Muscle Shoals Plant

Henry Ford, the Detroit automobile manufacturer, has made an offer to the government for the purchase of the nitrate plant at Muscle Shoals, Ala., on the Tennessee River, a plant which includes completed nitrate-producing units together with a partially completed dam across the river and a partially developed water power started by the government during the war and shut down the end of the last fiscal year. According to a memorandum from the Department of Commerce, the principal points in Mr. Ford's offer are:

(1) He will take a 100-year lease upon the Wilson dam and No. 3 dam and electric installation when completed. For this he proposes to pay interest at the rate of 6 per cent on the sum of $28,000,000, which is the estimate for the total cost, and to amortize not only this sum but the entire cost of both dams over a period of 100 years. (2) He offers to purchase all the nitrate plant and equipment, lands, steam plant, etc., for $5,000,000. (3) He offers to convert and operate the large nitrate plant for the production of fertilizer compounds and as a standby for government explosives in case of war. (4) He agrees to limit the profits of the fertilizer plant to 8 per cent, an independent board embodying representatives of the American Farm Bureau and the National Grange and the Farmers' Union to certify to this maximum.

In the announcement Secretary Hoover states: "The acceptance of the offer is entirely for decision by Congress, and that body no doubt will be greatly guided by Secretary Week's views in the matter. Mr. Ford has made a genuine proposal. It shows courage to agree to pay out $5,000,000; to spend further sums upon large works, and besides to take an annual obligation for about $1,500,000 for 100 years, and to agree to maintain a nitrate plant in reserve for the government for that period. Whatever may be the result, Mr. Ford's offer does prove what the public associations have contended —that the completion of this project has a commercial value."

Tunnel Engineers' Dismissal

(*Continued from p. 122*)

plea that it is holding such evidence as it may have for use in possible legal proceedings, the report sets forth in the following language its opinion as to the main issue involved:

"There can be no question that if anybody, private individual, corporation, or public commission, is dissatisfied with the services of any engineer in his or their employ, be he the most eminent consulting engineer or a student just out of college, he has the right to dismiss such engineer and seek other assistance. It is, however, a well established, even though an unwritten rule of professional ethics, that should an employer discharge an engineer, and especially an engineer in responsible charge of work or one employed as a consultant, without reasonable cause, that it is unethical for another engineer to take over the work or the position.

"The board of consulting engineers which was appointed and which, in conjunction with the chief engineer and his staff, has brought the enterprise to the point where its successful completion can be practically visualized, is not only a body of eminent engineers but also a body of eminent, well known and public-spirited citizens, and such a board, in connection with an enterprise of this character, should not be, and as a matter of fact cannot be, discharged just as one might discharge an office boy, and especially is it true at such a critical period of the work. Whatever the technical legal status of the matter may be, public sentiment, where properly informed, will not permit it."

The report goes on to say that so far as the committee is aware, the New Jersey commission, except in the matter of the Jersey City street widening, has never made any public statement of its grievances against the board or given the latter any opportunity to refute or explain the charges against it. The point is made, also, that, according to information received by the committee, the consulting engineers took no action in the matter of street widening, regard it is one of policy rather than of a technical engineering nature.

The public generally and the engineering profession especially, according to the committee's report, has as much confidence in the ability and integrity of the board of consulting engineers as it has in either of the commissions, and only the gravest reasons, it is held warrant such action as the New Jersey commission has taken. It seems to the committee, therefore, that either the New Jersey commission has no such reasons, having failed to make them public, or if it has, is remiss in proceeding with the work designed and sponsored by the same board, which it actually is doing. The report points out also that since the dismissal of the consulting board, the two commissions have arrived at a compromise agreement in the matter of street widening in Jersey City, but the matter of the

dismissal of the consulting board, which this dispute is said to have caused, or at least precipitated, is still open.

The committee concludes its report with the following opinion: "Your committee is unanimously of the opinion that the action of the New Jersey Interstate Bridge and Tunnel Commission, in attempting to dismiss the board of consulting engineers in the manner set forth in their resolution of May 14, acted in a manner prejudicial to the tunnel enterprise and the public welfare, and that, in view of all the circumstances which have been publicly known, it is certainly not in good taste and not in accord with a fine appreciation of professional courtesy and ethics for other engineers to attempt to fill the positions thus made available."

PERSONAL NOTES

DR. A. W. FREEMAN, Commissioner of Health of Ohio since 1917, having completed the term for which he was appointed, will become resident lecturer on public health administration, Johns Hopkins School of Hygiene and Public Health, Baltimore.

R. O. GALLAGHER, formerly superintendent of roads for Hamblen County, Tenn., is now resident engineer for the Tennessee highway department on construction of a federal-aid road between Mountain City and Bristol.

WILLIAM H. OKUM, formerly with the construction department of the New York Central R.R., and recently production engineer of the Avis Manufacturing Co., manufacturer of brass products, Brooklyn, N. Y., is now vice-president and works engineer of the Superior Wood Heel Co., Brooklyn, N. Y.

J. N. OLSON, assistant engineer Gulf Lines, Atchison, Topeka & Santa Fe Ry., at Galveston, Tex., has been transferred to the office of the chief engineer at Chicago, Ill.

ELLIS G. MIDDLETON has resigned as village engineer of Le Roy, N. Y., to become connected with the highway commission of West Virginia.

B. A. BRIGGS, formerly superintendent of streets of Colorado Springs, Col., is now with the Colorado state highway department.

J. H. HUNTER, for many years chief engineer of the Canada Starch Co. has been elected chairman of the Montreal branch of the Engineering Institute of Canada.

MAJOR JULES DUCHASTEL, city engineer of Outremont, Quebec, has been appointed president of the Automobile Association of Canada.

CHARLES M. MCKERGOW, of Montreal, Canada, has been appointed professor of the mechanical engineering department of McGill University.

R. C. LIMERICK, formerly project engineer of the Arkansas highway commission, has been appointed state highway engineer to succeed V. P. Knott, resigned.

J. POWELL WEHRUNG has been appointed county engineer, Runnels County, Tex., with headquarters at Ballinger, Tex.

W. C. MORSE, for a number of years identified with the regrade work in Seattle, Portland and other northwest cities, has opened offices in Seattle, Wash., to engage in general engineering-contracting work.

MAJOR CLIFTON E. HICKOK, city engineer of Alameda, Cal., since 1917 with the exception of a year spent in the Corps of Engineers, U. S. A., during the World War, has been appointed city manager of Alameda.

CHARLES E. HEWES, city manager of Alameda, Cal., has been appointed city manager of Long Beach, Cal.

DR. JOSEPH W. ROE, secretary of the Railway Car Manufacturers' Association and executive engineer of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., has been appointed professor of industrial engineering of New York University. He was graduated from Sheffield Scientific School, Yale University, in 1895. For several years he was identified with the department of mechanical engineering at Yale and the courses in industrial engineering there were developed by him.

HORACE M. BRINGHURST, formerly with Arthur G. McKee & Co., Cleveland, Ohio, is now sales engineer in charge of the steel lumber department of the General Iron Works Co., Cincinnati, Ohio.

JAMES P. HAYS has been appointed general superintendent for the Austin Co., Cleveland, Ohio, on the construction of a $250,000 soldiers' memorial auditorium at Mount Union College, Alliance, Ohio.

BRIG.-GEN. HARRY TAYLOR, Corps of Engineers, U. S. A., in immediate charge of river and harbor matters, has completed an inspection trip of the projects located on the Great Lakes.

CHARLES H. MOOREFIELD has been appointed state highway engineer of South Carolina, with headquarters at Columbia.

LT.-COL. FRANK B. KING, who was in command of the 112th Engineers in France during the World War, has been placed in charge of water and sewer extensions at Duncan, Okla., for V. V. Long & Co., Oklahoma City, Okla.

C. DOUGLAS BUCK has been appointed by the Delaware state highway commission as assistant to the chief engineer, Charles M. Upham, who will serve the Delaware commission in a consulting capacity during his term of office as chief engineer of the North Carolina highway department, a position he will occupy during a leave of absence from the Delaware department.

WILLIAM F. BROCK, an engineer in the department of public works, Columbia, S. C., has been appointed highway engineer with the U. S. Bureau of Public Roads, at Jackson, Miss.

ARTHUR M. SHAW, consulting engineer, New Orleans, La., has sailed for San Pedro Sula, Honduras, C. A., to supervise the design and construction of a complete sanitary sewer system there.

OBITUARY

A. L. HUNT, county engineer, Baker County, Fla., died at West Palm Beach, July 4, where he was attending the meeting of the state board of engineering examiners, of which he was a member. As a civil engineer he was connected with railroads of Florida for about 30 years. He was chief engineer of the old Orange Belt Ry., building the line from Sanford to St. Petersburg. He also laid out the town of St. Petersburg.

GEORGE W. POPE, contracting structural engineer for the Minneapolis Steel & Machinery Co., Minneapolis, Minn., and a member of the company's staff for 18 years, died July 9. He was graduated as civil engineer from the University of Wisconsin in 1898. During 1917 and 1918 he was in charge of the purchasing of fabricated steel at the Hog Island ship yards, and in 1919 he returned to the Minneapolis company to take charge of reinforced concrete work.

BUSINESS NOTES

THE MASTER TOOL CO., Cleveland, Ohio, has been organized with J. Nightingale, president; Charles F. Overly, vice-president and general manager; William Eckert, secretary-treasurer. The company will manufacture a new line of pneumatic tools and will specialize in reclaiming all types and makes of same.

THE BADGER CONCRETE MIXER CO., of Milwaukee and Watertown, Wis., has recently purchased a 27½-acre tract of land at Winthrop Harbor, Ill., where it will erect a factory for the manufacture of Badger concrete mixers and McVicker tie plates for the Railway Safety Tie Co. A workmen's housing project in connection with the new factory has been developed by the company.

DR. G. J. FINK, formerly with the Hooker Electrochemical Co., has been added to the technical staff of the chemical department of the National Lime Association, Washington, D. C.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Missouri Seeks to Dissolve Building Material "Trusts"

The Attorney General of the State of Missouri has filed ouster proceedings in the State Supreme Court against thirty-four corporations engaged in the production and sale of lumber, sand and gravel, according to recent press dispatches. The allegation is made that the defendant companies have entered into an unlawful combination to prevent competition and maintain excessive prices in violation of the state anti-trust law. The court is petitioned to forfeit the charters of the companies and either to confiscate their property or to impose a fine.

Twenty of the corporations involved are members of the St. Louis Lumber Trade Exchange and fourteen of these are members of the St. Louis Material Dealers Association.

The most recent action of the Attorney General supplements previous proceedings against sixteen corporations, members of the St. Louis Millmen's Association. In all, fifty defendant companies are named in ouster proceedings. The filing of the suits against the companies has followed an inquiry into the business practices of the three associations carried on by the attorney general.

Production of West Coast Lumber Drops Heavily

For the week ended July 7 the production of 104 mills reporting to the West Coast Lumbermen's Association was only 46 per cent of normal, a fact attributable, says a recent report of the association, to light demand, restricted credit and heavy stocks at the mills. New business and deliveries were likewise depressed, orders for the weeks totaling almost 38,500,000 ft. b.m., and shipments in excess of 36,000,000 ft. b.m. The opinion is expressed in the association's bulletin that, with a resumption of railroad purchases which will follow the distribution of the $500,000,000 to the railroads by the Federal Government, a gradual improvement is anticipated for the fall with a possible return to a normal condition by spring.

Changes in Retail Food Prices

The retail food index issued by the United States Department of Labor, through the Bureau of Labor Statistics, shows that there was a decline of only .3 per cent in the retail cost of food to the average family in June as compared with May. Wholesale prices, taking into consideration 327 commodities, decreased about 2 per cent in the aggregate. Compared with the high peak of prices in May, 1920, the June level of wholesale prices showed a decrease of 45.5 per cent.

A New Departure—Engineering News-Record's Construction-Cost Index Number

Steel, Lumber, Cement, Common Labor Are Basis of Index Figure Which Rose to Peak of 273.8—Is Now 194.82

Since 1900, and particularly after 1910, complaints concerning the rising cost of living have been increasing in volume both in Europe and America. Numerous systems for studying this increase have been developed. In the United States, according to the Bureau of Labor Statistics, six series of index numbers relating to wholesale prices are currently maintained, four of them by financial papers. In England there are three important series; one in France; in Germany there were three up to the time of the war; while the Governments of Canada, Australia, South Africa, India, Netherlands and New Zealand publish official index numbers, and private investigators have made series for Belgium, Norway, Sweden, Austria, Spain and Italy. Most of the series were founded comparatively recently, the oldest being that of the *London Economist*, which was started in 1869.

Probably the chief reason why reliable studies of price changes were not made until comparatively recently was the prejudice felt against price averages. Early investigators were hampered by the dearth of quotations. The first index number, by Carli in 1750, was constructed with the per cent increases of three commodities—grain, wine and oil. Improved business organization and the availability of a greater amount of data have minimized the lack of confidence in the accuracy of averages of price variations. Furthermore better transportation made wholesale prices in the larger cities basic for many local markets. Today the value of index numbers is generally acknowledged.

A Construction-Cost Index Number

Not only has the doubt as to the trustworthiness of index numbers been largely dissipated, but the pendulum of public opinion has actually swung too far in the positive direction. Index numbers must be understood in order to be applied usefully. Few of the widely used index numbers are made to serve one special purpose, most of them being designed to show only changes in the price level. Despite their limitations, however, they are employed to show rise and fall in the cost of living, depreciation of gold, alternations of business prosperity, evidence that wage schedules ought to be revised, the effect of tariff revision, and the reason for political avalanches.

Engineering News-Record proposes to publish in the first issue of each month an index number that will indicate the trend of construction cost in the United States. To achieve this the three major materials least influenced by local conditions have been selected. These materials are steel, lumber and cement, and they are combined with the cost of common labor.

Index numbers are called "simple" or "weighted," according to whether they are a mere average of figures having equal importance or the average of figures which have been given their relative importance. It would be obviously incorrect to add the prices of, say, a ton of steel, a barrel of cement, a thousand feet of lumber and a week's wages, dividing the result by four. One might with as much justice (or error) add a pound of steel, a bag of cement, and a board foot of lumber. Instead the relative importance of the four factors in construction operations has been determined, as closely as the problem permits.

TABLE I—PRICES OF MATERIALS AND LABOR

	Structural Steel Pittsburgh Base	Cement Net Bbl. F.o.b. Chicago	Pine, Base New York	Common Labor Average for Country
1913	$1.50	$1.19	$28.50	$0.19
1914	1.15	1.14	29.00	.20
1915	1.30	1.16	28.00	.21
1916	2.55	1.44	31.50	.23
1917	3.67	1.77	37.75	.32
1918	3.00	1.97	43.25	.45
1919	2.55	2.01	50.00	.51
1920	2.95	2.09	67.50	.56
1921 (6 mo.)	2.25	2.20	57.00	.57
July, 1920	3.10	2.15	65.00	.70
July, 1921	2.00	2.17	48.00	.51½

To arrive at a correct balance the first investigation was of the total annual production in the United States of steel, lumber and cement, and of the number of common laborers exclusive of farm labor. The years 1913, 1916 and 1919 were selected for the materials. The average production of steel was about 33,000,000 tons; for cement, 90,000,000 bbl.; for lumber the average of 1913 and 1916 according to government figures was 42,000,000 *M* ft. b.m. The number of common industrial laborers (1910 census) is 4,000,000.

To convert these factors into money, so that they would be comparable, 1913 was selected as the base year, and index numbers were computed from that year to date, using, where possible, the prices published monthly in *Engineering News-Record*. All these prices have been carefully verified. The steel price used is the Pittsburgh base for structural shapes. For cement, the consum-

er's net price exclusive of bags, f. o. b. Chicago was used, as being representative. For lumber, the New York base (3 x 12 to 12 x 12) on Southern pine was used. For labor, from 1913 to 1920 inclusive, the rates paid common labor in the steel industry were used with slight revision, and since 1920 the average common labor rates for the nineteen or twenty cities covered monthly in *Engineering News-Record*. These average prices are given in Table 1.

The following figures, found in the preceding paragraphs, help in determining the proper weight to be given the various materials and labor:

33,000,000 tons steel @ $0.30	$990,000,000
90,000,000 bbl. cement @ $1.19	107,100,000
42,000,000 M. ft. b. m. lumber @ $28.50	1,197,000,000
1,200,000,000 man days @ $1.52 (8 hrs.)	1,822,000,000
	$4,116,100,000

It is natural that the question should arise why total production is taken instead of the amount of steel, lumber, cement and labor used on construction work. One reason for using total production is that total production influences cost of construction. In the case of steel, for example, even if it were possible to segregate from the total the amount of steel used on construction, an indeterminable error would be introduced by using the latter. Construction cost is influenced directly or indirectly by the cost of machinery and tools, by the demand for armor plate and rails, and by the export demand. It is therefore desirable to take into consideration the entire production. The same is true for cement, and only less so for labor. As regards labor, the shift from one industry to another is of such nature as to necessitate considering the total for common labor (exclusive of farm labor) in determining the part it plays in construction cost.

With the principles outlined in the preceding paragraphs as a basis, and with the aid of the judgment of experienced construction men, the elements of the computation adjusted to give 100 for the base year 1913 are as follows:

2,500 lb. structural steel, $1.50 per 100 lb.	$37.50
6 bbl. cement, $1.19	7.14
600 ft. b. m. pine, $28.50	17.10
200 man-hours, $0.19	38.00
	$99.74

The *Engineering News-Record* Cost Index Number, computed as above, starts at approximately 100 in 1913, and is carried forward without intermission to July, 1921, where the number stands at 194.82. It will be published regularly in the first issue of each month. During the last nine years the number has risen to a maximum of 273.80 in June, 1920, and has shown yearly figures as tabulated below:

1913	99 74
1914	92 99
1915	98 26
1916	137 29
1917	189 82
1918	202 77
1919	207 81
1920	238 79
1921 (7 Mo.)	214 39
July, 1921	194 82

Employment in New York State

Though there was a reduction of 2 per cent in employment in factories of New York States in June as compared with May, a decided improvement in some industries, and particularly in textiles, is shown in statistics prepared by the state industrial commission. The number of workers in the textile industry in June as compared with January increased 52 per cent. The total decline in employment for all industries during the period of depression has been 28 per cent. Save for a small decrease in rope and twine manufacture and cotton goods finishing every branch of the textile industry showed a gain during June. A statement from the industrial commission asserts that "seasonal activity in the building trades was responsible for greater production in June in the manufacture of brick and lumber mill products. The cement and plaster industry reported a decrease in employment during the month. . . . The metal industries again showed the heaviest reduction."

Railroads Carried 2,249,657,625 Tons in 1920

The total tonnage of commodities transported over the Class 1 railroads of the country during the year ended December 31, 1920, totaled 2,249,567,625 tons. Of that tonnage 53.60 per cent was made up of the products of mines. Manufactured articles and miscellaneous comprised 21.91 per cent of the tonnage carried, while products of agriculture furnished 9.78 per cent; products of forests 8.74 per cent; all less-than-carload freight, 3.98 per cent and products of animals, 1.99 per cent.

Highway Bids on 68 Miles Are 86 Per Cent of Estimate

Bids opened by the New York State Commission of Highways on July 13 revealed the fact that the low bids on the eighteen construction and repair projects covering 68 miles of highways totaled $2,327,882, or approximately 86 per cent of the engineers' estimate on the work. There was not one project advertised upon which no bids were received and the total number of bidders was 111. Ninety-one contractors bid to build 60 miles of road of various types, one project of 8.8 miles attracting eighteen bidders. Another project of a length of 3.2 miles received twelve bids and another of five miles, ten bids. A repair project 3.66 miles long attracted eleven bids. Only three projects received two bids or under and two of these projects were repair jobs each, less than a mile long.

Not only were the low bids 14 per cent under the engineer's estimate, but the high bids totaled $2,603,717, of approximately 96 per cent of the engineer's estimate. On the project for which 18 contractors bid, the low bid was $50,000 under the engineer's estimate and there was a difference of less than $40,000 between the low and the high bidders.

American Plan Probable Result of San Francisco Strike

The American plan is gaining popularity rapidly as a means of getting back to work on a satisfactory basis after the long period of controversy between builders and the unions in the San Francisco Bay district. (Previous reference to the controversy there appeared in *Engineering News-Record*, Feb. 3, p. 239; April 14, p. 660; and June 2, p. 970.) As a result of the rejection of the arbitration award by the building trades council on April 30 and the failure of efforts to induce that body to abide by the terms of the arbitration agreement, the builders exchange determined to have no further relations with the building council.

On June 13 the American plan was inaugurated with a fixed wage scale based upon the reduction of 7½ per cent prescribed in the arbitration award. In the month that followed the architectural iron workers, elevator constructors and teamsters unions accepted the American plan and returned to work on that basis as did also members of one carpenters union. The indications on July 13 were that despite a loyalty to their unions and because of dissatisfaction with union leaders, the tendency of union men was to accept the American plan rather than remain idle.

Building Mechanics Imported

During the strike there has been little or no disorder. The builders exchange is conducting employment agencies with branches in Los Angeles, Seattle, Portland, Salt Lake and other cities, and building mechanics are being brought into San Francisco as fast as they are needed in the work under way. These men have been brought in under the assurance that if found to be qualified craftsmen, as claimed, they will have steady employment for ninety days and equal chances with union men for further employment if and when the unions return to work. A hotel was leased for the accommodation of these men. On July 13 there were more than 1,200 building construction jobs, large and small, under way in San Francisco and vicinity and about 4,000 men at work, of which 1,000 had been brought in from other points.

Commercial, industrial and financial interests of San Francisco are supporting the American plan movement, and an industrial association has been formed whose members have pledged a fund of $1,300,000 to maintain the present movement on a permanent basis. A statement of the program of this association is that:

It is not aimed at the destruction of unions, but has adopted the fundamental policy that dealings shall be with individual employes only and agreements will not be made with unions. There shall be no restriction in output or the use of materials or machinery. Work shall be on a basis of an 8-hour day, a minimum 5½ day week, time and a half for overtime, double time for Sundays and holidays.

Building Wage Disputes in Several Cities Settled

Adjustment of building-wage schedules downward has been made in several cities during the past few weeks. Arbitration proceedings are in progress in others and in still other localities strikes or lockouts continue to defer building construction.

New York City building trade mechanics, whose associations are members of the building trade council, have refused to confer with the building trades employers association on the question of wages, asserting that there was no need for such a discussion, inasmuch as there was a contract existing between the council and the employers association which established a definite rate of wages until Jan. 1, 1922. Practically 100,000 men would be affected were a wage decrease put in effect in New York City. It is possible that the employers association will be able to negotiate with plasterers, stone cutters, brick layers and painters, as those unions are not members of the building trades council.

A strike of twomonths' duration in Providence, R. I., was brought to a close last week through the agreement made between the plasterers' union and the contracting plasterers whereby the wages shall be $1.05 an hour until July 1, 1922. This represents a reduction of 10c. per hour. Most of the other trades had made previous settlements.

Untermyer's Decision

The decision of Samuel Untermyer, the arbitrator in the Westchester County, New York, building trades dispute, has been made public and has been accepted by both sides to the controversy in accordance with the conditions under which he was chosen arbitrator. Mr. Untermyer's decision fixes the wage scale at $8 a day from September 1, which means that the building trades mechanics will receive $9 up to that date. Corresponding reductions are to be made after September 1 in the pay of those receiving less than $9 daily now. Mr. Untermyer did not confine his decision to a fixation of wages but discussed other conditions in the building industry. He finds that labor is being exploited, that the cost of living reduction is sufficient to warrant a dollar decrease in wages, and that the five-day-a-week arrangement of one of the local unions is a "vicious precedent, detrimental alike to the welfare and efficiency of the men and to the prosperity of the country if it were to become a universal rule."

Wages in many of the building trades in Trenton, N. J., have been reduced from 50c. to $2 a day by the arbitrator. Carpenters, tile fitters, metal lathers and electricians will continue to receive $8 per day. The new schedule which became effective July 18 maintains the 44-hour week, time-and-a-half pay for overtime and double pay for Sunday.

The investigating committee created in Rochester, N. Y., for the purpose of making an investigation of the building-trades situation has made public a voluminous report in which it offers eight recommendations as a basis for adjustment of the present controversy in the building trades. The recommendations are (1) that wages be arbitrated within ten days after submission to the arbitrator; (2) that upon an award being made the men return to work under the terms of the old agreement; (3) that the right to boycott non-union material be held in abeyance during the term of the agreement; (4) that no discrimination be made against the men now employed by the contractor; (5) that there shall be no restrictions placed upon the amount of work performed by an individual or group of individuals nor shall production be limited; (6) that there shall be no cessation of work at any time on account of jurisdictional disputes; (7) that there shall be suitable procedure for conference, conciliation and arbitration; and (8) that pending such proceedings there shall be no walkouts, strikes or lockouts.

Ohio Highway Work Averaging $1,000,000 Weekly

More than $1,000,000 a week was spent on the highways in Ohio during the latter part of June and this amount will be continued if not increased during the coming few months. Vouchers for a total of $2,461,504 were paid out by the Ohio Highway Department for work done between June 15 and July 1. This is the largest amount every spent in that short period of time since the department was organized.

Bids Opened on Wilmington Port Work

The Hughes Foulkrod Co., Commonwealth Building, Philadelphia, was the low bidder on the Wilmington, Del., port work, when bids were opened last week. The total bid of the Philadelphia concern was $1,311,000. Seven other bidders bid on the total work which includes berthing and retaining bulk heads, a marine cargo shed, a coast-wise cargo shed, cafeteria and barracks, grading and filling, track work and miscellaneous installations. The two other bidders next to the low bidder were Snare & Triest, New York City, and John R. Wiggins Co., Philadelphia

Although but eight contractors bid upon the entire work, combination bids were received from thirty-three contractors.

Pennsylvania Receiving Bids on 60 Miles of Durable Pavement

Until Aug. 5, the Pennsylvania State Highway Department will receive bids for the construction of approximately sixty miles or hard surface paving. Most of the work is to be of one-course-reinforced concrete, though alternate bids including a bituminous surface on a concrete foundation will be received on several projects. There are twenty-seven projects in twenty-five counties in the list.

The Government's Part in Solving the Housing Situation

In addressing the National Association of Real Estate Boards in Chicago, July 15, Herbert Hoover, Secretary of Commerce, asserted that, though the federal government had a responsibility in the solution of the housing situation, it had no notion whatever of going into the housing business either directly or indirectly. "It will not fix prices nor wages," asserted Secretary Hoover, but he said that what assistance it could offer would be directed toward driving every combination out of business that attempted to restrain trade, toward facilitating the flow of credits into home-building channels, and toward accumulating ad disseminating information, scientific study of certain problems in materials and methods, and in co-operation with the industries to receive voluntary reduction in wastes so that the cost of homes might be decreased.

Investment in tax-free securities Secretary Hoover asserted had materially diverted capital that should have been used for building, and had resulted in increasing the interest rate to home builders. An examination of saving institutions, the cheaper lines for home buildings, he said would reveal that the total sum of money available, either in mutual savings banks, building and loan associations, or in savings departments of national or state banks and trust companies, or in the assets of insurance companies, would aggregate $22,000,000,000. Eliminating building and loan associations, all of whose assets are used in building, and the actual savings banks who devote from 40 to 50 per cent of their deposits for this purpose, he said that it would probably be found that savings departments of the national banks or the state banks of the trust companies and of the insurance companies which comprise more than half of the total savings, do not loan for home buildings more than 10 to 15 per cent of their deposits or savings assets. Such a diversion of savings money into commercial channels meant, asserted Secretary Hoover, a natural drift toward a higher interest rate.

Remedial Measures

Inasmuch as Secretary Hoover asserted he believed a more stable economic system would obtain were a more regular proportion of savings made available to home buildings, he deemed the proposed amendment to the Federal Reserve Act, through which a greater per cent of savings deposits of national banks might be used for building purposes, was an advisable change. He also said that he believed it would be a highly desirable condition if 40 to 50 per cent of the deposits in postal savings banks could be used for home-building purposes.

One of the things which the Government is undertaking and which Secretary Hoover asserted should be of general interest, is "an organized effort to solve certain problems in waste by

organized co-operation with the industry and by scientific investigation throughout the Department laboratories." A nation-wide scientific revision of the building code, which would doubtless lead to greater strength, durability and fire resistance of structures yet which would result, in a more scientific use of materials, in a decreased construction cost, Secretary Hoover asserted would be followed by "a scientific revision of the fire insurance regulations, so that suitable materials may be more promptly utilized and the art of building more rapidly advanced." He said that the Government was now undertaking a study of the activities of various communities in the United States and foreign countries in the development of home building, the results of which investigation would be generally circulated.

Contract Price for Mile of Road Is $16,332

The State Highway Department of New Hampshire recently awarded a contract for the construction of a bituminous macadam road 18 ft. wide and 1.01 miles long at a cost of $16,332. Included in the items of work are 2,120 cu.yd. of earth excavation, 1,671 tons of bituminous macadam, 450 tons of crushed native stone, 675 cu.yd. of field stone, 21,847 gal. of bituminous material, and 10,710 yd. of modified surface course. Another contract was let at the same time for 2.2 miles of modified asphalt pavement at a total cost of $55,932. This is an average of $25,444 per mile. In the second contract were included 6,368 cu.yd. of earth excavation and borrow, 2,677 tons of bituminous macadam, 23,274 sq.yd. of paving.

Builders Who Employ Ex-Service Men To Get Contracts

(London Correspondence.)

The British Minister of Labour has announced that from September 1 next, contracts for the government on which bricklayers, plasterers, slaters and tilers were employed would be let, save in exceptional circumstances, only on condition that the contractor was employing ex-servicemen, in accordance with the conditions of the government's dilution scheme. (*Engineering News-Record*, June 23, p. 1099.) Every effort is being made by government departments to insure that a proper proportion of ex-service men is being taken on and employed on existing contracts.

The attitude of the trade unions concerned in the majority of cases is hostile.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 7, the next, on August 4.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb	$3.03	$4.00	—$4.30	$2.93	$3.31	$4.65	$4.25	$4.60	$5.00
Structural rivets, 100 lb	4.40	5.25	5.75	4.88	5.20	—5.50	6.00	5.50	8.50
Reinforcing bars, ¾ in. and larger, 100 lb	2.93	3.25	3.75	3.00	3.53½	+4.02½	2.35	4.00	4.25
Steel pipe, black, 3½ to 6 in. lap, discount	51%	50.65-5%	45%	58½%	—53.9-5%	36%	49.80%	47½%	5%
Cast-iron pipe, 6 in. and over, ton	49.10	59.22	—57.50	49.10	57.80	—62.00	80.00	65.00	75.00
Concreting Material:									
Cement without bags, bbl.	2.60@—2.70	(del.)—2.50	2.80	2.17	2.46	3.10	3.09	3.10	4.28
Gravel, ¾ in., cu.yd	2.25	2.35	3.00	2.25	2.00	2.50	2.25	1.50	1.50
Sand, cu.yd	1.25	1.40	2.50	2.25	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	—1.90 to 2.00	2.25	2.80	2.50	2.25	3.50	2.25	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	47.00	—38.00	35 00	55 00	36.00	47.00	27.00	—23.00	+120.00
Lime, finishing, hydrated, ton	—18.49	—20.00	25 00	20.00	29.00	32.00	25.40	24.00	—28.00
Lime common, lump, 200 lb. bbl.	3.79	—1.45	2.75	1.65	1 50	3.10	2.25	2.75	15.00
Common brick, delivered, 1,000	18.40	—11.00	+12.65	12.00	17 00	14.00	18.00	—14.00	18.00
Hollow building tile, 4x12x12, block	Not used	.14	.13	.09475	.092	.09	.12½	.11	.15
Hollow partition tile 4x12x12, block	.1232	.15	.13	.07410	.092	.10	.14½	.12	.....
Linseed oil, raw, 5 bbl. lots, gal	.76	+.79	—.97	.84	.88	+.96	.96	.79	.84
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	1.00	.50	.50@.63½	.81½	.75	.....
Common labor, non-union, hour	.....	.25	.35@.45	.45	.50	.37½@.50	.50@.55	.50	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 300-lb. bbl.; both lump and hydrated quoted alongside dock. Sand gravel and crushed stone are quoted alongside dock. **Chicago** quotes hydrated lime in 50-lb. paper bags. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.60 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime; white is 15c. additional. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. **Dallas** quotes lime by the 180-lb. bbl. Steel and crushed stone are quoted f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse.

Changes Since Last Week

Concreting materials, particularly gravel and crushed stone, show a noticeable drop in price in New York. Gravel is quoted at $2.25 per cubic yard, as against $2.50. Crushed stone shows a drop to $1.90@$2. Cement ranges between $2.60 and $2.70 delivered.

Hydrated lime is down in Montreal, Atlanta and New York.

Quotations on structural shapes in Dallas show a decline of 20c. per 100 lb. while Denver reports a drop of 50c. in structural rivets.

Minneapolis reports increased discounts on steel pipe, the present discount on 3½ to 6-in. lap-welded being 53.9-5 per cent, as against 51.9-5 per cent.

Both Denver and Dallas show a marked drop in cast-iron pipe—a reduction of $8 per ton in Denver and $7.50 in Dallas.

Pine is quoted in Atlanta at $38 as against $40. Seattle quotes Douglas fir at $23 as against $28.50.

Linseed oil is steady, the only fluctuations being an increase of 1c. per gallon in Atlanta and Denver and a drop of 1c. in Dallas.